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REPORT

OF THE

ENTOMOLOGICAL DEPARTMENT

OF THE

New Jersey
Agricultural College Experiment Station,

BY

JOHN B. SMITH, Sc.D.,

For the Year 1893.

TRENTON, N. J.:
THE JOHN L. MURPHY PUBLISHING COMPANY, PRINTERS.
1894.

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CONTENTS.

PAGES.

REPORT OF THE ENTOMOLOGIST 437–603
General Review 439–448
Plan of Work 439
Sweet Potato Flea-beetle Experiments 439
Melon-louse Investigation 440
Effect of Cold Winter on Insects 440
Onion Maggots in Cumberland County 440
Checked by Application of Kainit 441
Onion Thrips 441
Wheat-head Army-worm Appearance 442
Corn Insects 442
Cutworms 442
Root Webworms 442
Effect of Mineral Fertilizers on 443
Corn Bill-bug 443
Pale-striped Flea-beetle Injurious to Carrots 443
Strawberry Weevil Injury 443
Pear-midge Experiments 444
Pear-psylla Appears in the State 444
New Asparagus-beetle, Spread of 444
Remedy for Larval Attacks 445
Potato Pests 445
Cranberry Insects 446
Modified in Wisconsin 446
Introduced into Washington 446
Photography in the Laboratory 447
Legislation Against Insects 447
Work for World's Columbian Exposition 448
Entomology in the Crop Bulletin 449–453
The Pear Midge 453
History of Work on 453
Its Spread in the State 454
Observations at New Brunswick 454
Success of Application of Kainit 454
Laboratory Experiments with the Mineral Fertilizers 455
With Chloride of Magnesium 457
Life History 458
Oviposition 458

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REPORT OF THE ENTOMOLOGIST—*Continued.* PAGES.
Larvæ.. 459
Pupation 459
Remedies to be Applied 459
The Pear-tree Psylla 460
Its Appearance in New Jersey 460
Classification 461
The Injury Done.. 461
Description of the Insect.. 461
The Life History 462
The Insect in New Jersey.. 464
Remedies 464
The Wheat-head Army-worm 465
Record of its Appearance 466
Life History 467
Description of the Moth 468
Remedies 469
The Strawberry Weevil 470
Description of Insect and Injury 470
Life History and Habits 471
Remedies and Suggestions 473
The Corn-root Webworms 473
Reported Injury from 473
Observations on 474
Habits of the Insects.. 474
Life History 475
Injury on Corn 476
Remedies 477
The Pale-striped Flea-beetle. 478
Observations on 478
Injuries Caused by 478
Life History 479
Remedies 480
The Chestnut Weevils 481
Chestnut Groves in New Jersey 481
Injured by Worms in Nuts.. 482
Description of the Insects and Life History 483
Remedies 483
Suggested Practice 484
Beneficial Insects.. 485–603
Injurious and Beneficial Forms Defined 485
Balance of Nature as Part of the Insect Problem 486
Some Causes of Increase in Injurious Species 486
Imported Insects 487
Lady-birds versus Icerya 488
Relation of Parasite to Host 488
Beneficial Insects of No Practical Use to the Farmer 489

Digitized by Google

REPORT OF THE ENTOMOLOGIST—*Continued.* PAGES.

Orders of Insects.. 490
Thysanura—"Spring-tails," "Fish-moths," etc..... 490
Their Habits..... 491
Neuroptera 491
Dragon-flies and Their Habits..... 492
Ephemeridæ or "Day-flies"..... 493
Stone-flies..... 493
Termites or White Ants 494
Book Lice 495
Biting Lice 496
Dobsons and Hellgrammite..... 496
Aphis-lions..... 497
Ant-lions 500
Scorpion-flies 501
Caddice-flies 502
Orthoptera 503
Mantidæ or Soothsayers..... 503
Generally Injurious. 504
Hemiptera..... 504
General Habits..... 505
Homoptera—Plant Lice, etc 505
Heteroptera..... 505
Habits of..... 506
The "Wheel-bug"..... 506
Spined Soldier-bug 507
Odor of Bugs..... 507
Lepidoptera—Butterflies and Moths..... 508
How Useful..... 509
Characters of Larvæ..... 509
Some of them Predaceous 510
Diptera or Flies 511
Sheep-tick, a Degraded Fly 511
Bee Louse..... 511
Fleas and Their Life History..... 511
Mouth Parts of Flies 512
Form of Their Larvæ. 513
The Midges..... 513
Fungus Gnats..... 514
Crane-flies..... 515
Long-horned Flies are Generally Injurious..... 516
Horse-flies 516
Robber-flies 518
Bee-flies 520
Their Mouth Parts 521
Habits of Larvæ..... 521
Empid Flies..... 522

Digitized by Google

REPORT OF THE ENTOMOLOGIST—*Continued.* PAGES.

Scenopinus under Carpets 522
Dolichopodid Flies..... 523
Flies with Maggot Larvæ..... 523
Syrphidæ 523
Rat-tailed Larvæ 524
Chrysanthemum-fly 524
Aphis-feeders..... 524
Syrphus Torvus..... 525
Pipiza Radicans Feeds on Root Lice..... 526
Conopid Flies..... 526
Bot-flies 527
Sheep-bot 527
Muscid Flies..... 527
Scavenger Flies 529
Screw-worm Fly..... 529
Peacock-flies..... 530
Tachinid Flies..... 530
Root-maggot Flies 533
Pommace-flies.. 534
American Meromyza..... 535
Coleoptera 535
Habits and Characters..... 535
Snout-beetles 536
Bark-beetles..... 536
Lamellicornia 537
May-beetles 537
Tumble-bugs 537
Feet Structure of Beetles..... 538
Long-horned Beetles..... 539
Chrysomelidæ or Leaf-beetles..... 540
Elateridæ or Snapping-beetles..... 542
Buprestidæ..... 544
Fire-flies 545
Soldier-beetles..... 546
Flower-beetles..... 547
Ptinidæ 550
The "Death-watch" 551
Rove-beetles..... 552
Lady-birds—Coccinellidæ 553
Nine-spotted Lady-bird..... 553
Cycloneda Sanguinea..... 555
Two-spotted Lady-bird..... 555
Convergent Lady-bird 556
Glacial Lady-bird 556
Megilla Maculata 556
Squash Lady-bird 558

Digitized by Google

REPORT OF THE ENTOMOLOGIST—*Continued.* PAGES.

Burying-beetles ... 559
Histeridæ ... 561
Dermestidæ ... 562
Nitidulidæ ... 562
Tiger-beetles ... 563
Ground-beetles ... 564
Caterpillar Hunters ... 564
Carabus Species ... 565
Bembidium Species ... 566
Pterostichus Species ... 566
Platynus Species ... 566
Lebia Species ... 566
Harpalus Species ... 567
Heteromera ... 568
Blister-beetles ... 568
Their Life History ... 569
Striped Blister-beetle ... 572
Black Blister-beetle ... 573
Epicauta Pennsylvanica ... 573
Tenebrionidæ ... 574
The Meal-worm ... 574
Hymenoptera ... 574
Characters and Structure ... 575
Saw-flies and Plant-feeders ... 575
Willow Saw-fly ... 576
Wheat-stem Saw-fly ... 577
Pigeon Tremex ... 578
Parasitica ... 578
Cynipidæ or Gall-flies ... 579
Ichneumon-flies ... 580
Braconid Parasites ... 584
Chalcid Parasites ... 587
Proctytrypid Parasites ... 589
Pelecinus Parasite ... 591
Cuckoo-bees ... 592
Ants and their Habits ... 592
Wasps ... 596
Digging Wasps—Mutillidæ ... 596
Scoliidæ ... 596
Pompilidæ ... 596
Potter-wasps ... 598
Bembecidæ ... 599
Paper-making Wasps ... 599
Bees and Their Habits ... 601
Conclusion ... 603

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REPORT OF THE ENTOMOLOGIST.

JOHN B. SMITH.

GENERAL REVIEW.

The season of 1893 has not been remarkable for any severe outbreak of insects, although a very great deal of damage has been done, as usual. In the work that was planned for the year, an investigation of root maggots, the completion of the life history of the sweet-potato flea-beetle and the discovery of the alternate food plants of the melon-louse held leading positions. Quite early in the season, several trips were made to Swedesboro, at which point flea-beetles were most numerous. A large number of plants were examined in the field with the utmost care, many other plants were taken and examined in the laboratory, while yet others were brought in and grown in jars to furnish food for the beetles collected for experimental purposes. Between one and two hundred beetles were collected, in the hope that eggs and larvæ might be obtained. They were placed upon the plants growing in jars, fed freely and copulated readily. After the beetles had died off, which occurred in about ten days after they were brought in, the plants were taken out and washed, as was also the sand in which they were grown; but, in spite of the care with which the search was conducted, neither eggs nor larvæ were found. Nor did I succeed in finding on the plants brought in from the fields, where flea-beetles were in any quantity, any specimens of larvæ. The nearest approach to anything that might be considered as the work of the larva of this species was in some of the finer root fibers, which appeared to have been eaten out; but I found nothing that would give me absolute certainty. I am inclined to believe, although it is a belief not supported by proof, that the early stages are passed in these small rootlets, of which there are an enormous number on the sweet potato plants. Two facts were learnt: The first is, that the beetles make their appearance again in midsum-

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mer; and the second, that they continue on in small numbers during the balance of the season and pass the winter in rubbish of any kind that they can find. Specimens have been sifted from the debris found in the nests of field mice gathered in January, and it is very probable that in such places and in similar localities the winter is passed. This information does not affect the recommendations that have been made as to remedies, and what has been published in the last report applies as before. There was considerable injury to sweet potatoes during the present year by cutworms, though they were not so abundant, locally, as during 1892.

In the hope of discovering the alternate food plant of the melon-louse, I made several trips to Port Monmouth and various points in Cumberland, Gloucester and Salem counties, but without meeting with the desired success. I carefully examined vegetation of all kinds in the localities visited, and collected a very large number of species of plant lice, which were carefully examined, whenever they showed the slightest tendency to resemble the species sought for; but I did not find a single specimen of the desired species. Quite late in the season, a very few specimens were found on the melons, but no injury was done, the creatures not seeming to find the temperature or other weather characteristics suitable for rapid increase. I did not receive from any locality any complaints of injury from this insect. The remarkably cold winter of 1892–93 had the effect of very greatly reducing the number of two of the melon pests—that is, the "boreal lady-bird" and the "squash-bug," neither of which was as abundant this year as it was in the past. Indeed, the lady-bird was, comparatively, a rarity in the localities that I visited. Little additional information was gained concerning the squash-borer, which also seemed to be less abundant than during some previous years. It was, however, determined that a small percentage of larvæ transformed to adults in the fall of the same year, but these are unable to reproduce their kind because there is no time for a second brood of larvæ. It was also determined that, normally, the larvæ remained in the cocoon unchanged during the winter, transforming to pupæ only a very short time previous to their emergence as imagos in spring.

Onions are grown on quite a large scale in Cumberland county and also in parts of Warren county. On a smaller scale, they are grown throughout the State, and in many localities they suffered severely from the root-maggot. How to deal with this insect has been a ques-

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tion, and none of the remedies that have been suggested have proved satisfactory in all cases. The Entomologist is under a very serious disadvantage in studying forms of this kind, because he has no facilities for growing plants, and therefore no opportunity to make any satisfactory tests with insecticides on insects of this character. It was the intention to find some grower on whose land the onion-maggots were rather plentiful, and to carry on experiments there, under ordinary field conditions, which would have, of course, given the best and most satisfactory tests of the substances applied. Quite early in the year, Mr. Theo. D. F. Baker, of Bridgeton, wrote that the maggots had suddenly made their appearance in his land in very large numbers, and he asked for suggestions. This was rather a surprise to me, because Mr. Baker had stated positively during the preceding winter that no trace of the onion-maggot had been theretofore seen on his land. He repeated this statement, and added that he has known the insect from other localities and felt positive that this was the first appearance in his fields. Nor did any of his neighbors seem to have known of it until the present season. The appearance in such numbers, therefore, was a matter of some surprise. Fortunately, the growers of onions in that immediate vicinity were fully alive to the consequence that might result from the increase of the insect, and they at once adopted heroic measures. The entire fields were gone over, row by row, and all plants that showed signs of infection were taken out bodily and afterwards destroyed. Then heavy dressings of kainit were applied, with the result that no further traces of these maggots were seen at any time later in the season. Another insect which had not been previously noticed in any number was the onion-thrips. This little creature was on the leaves in perfectly astounding numbers. The result of their eating was visible in the form of small yellow spots, increasing in size until the tips of the leaves became yellow or brown, and, finally, the whole stalk had a whitish appearance, very different from the usual dark green of a healthy onion plant. Some experiments were made later on with fly larvæ, which resembled those of the onion-maggot and were at first mistaken for them, and these will be found detailed at some length further along in the report. I am strongly inclined to attribute the cessation of the attack and the absolute absence of a second brood to the very active measures taken as soon as the insect was discovered, and as all the growers combined in the campaign, the result was complete. It

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furnished an object lesson of no mean value, as to the possibilities in the way of controlling insect injury, where intelligent, systematic and combined efforts are made.

A somewhat unlooked-for occurrence was the appearance of the "wheat-head army-worm," in some numbers, in Hunterdon, Mercer and, perhaps, one or two neighboring counties, where they did a very considerable amount of damage by eating the kernels of grain, in whole or in part, scattering them over the field so as to make it "look like a threshing floor," as one farmer expressed it. This is an insect that appears in some numbers each year, though it is very rarely, indeed, noticed by the farmers. The circumstances that led to its unusual increase during the present year have not yet been satisfactorily explained.

Great damage was done by the Angumois grain moth, during the winter of 1892–93, to grain stored in the mow, or left out in the fields until late, before being threshed. In parts of Burlington county, where this insect was most troublesome last year, many of the farmers followed this year the advice given by the Entomologist and threshed their grain as soon as it was harvested. In a few localities, the wheat louse made its appearance in small numbers, and in some cases produced uneasiness; but nowhere did it become numerous enough to do any perceptible injury, its natural enemies sufficing to keep it in check.

Corn suffered quite severely from insect attack of various kinds. Cutworms were unusually abundant, and much replanting was made necessary by their attacks. During the few years last past a "root webworm" has been becoming more and more abundant, and this year did very serious injury throughout the southern counties and extending northward into the center of the State, at least; how much further, I have no means of ascertaining, from lack of reports from that section. This "webworm" is originally a grass insect, and is very similar, if not identical, with one that feeds on and in roots of plantain. It is therefore on old sod land that it is very much more abundant than elsewhere, and, in fact, other fields are quite usually exempt. It is also a fact, which I was enabled to verify this season in several instances, that where the mineral fertilizers had been used, very little or no injury appeared, even where the corn was planted upon old sod. I am distinctly inclined to attribute this difference to

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the use of the mineral fertilizers, and consider it another argument for their more general employment.

Of the "corn bill-bug" I heard comparatively little during the present season, and, apparently, some natural check existed in most localities, preventing its usual increase. I am as little able to suggest the nature of this natural check as I am to explain what check was removed to enable the "wheat-head army-worm" to increase so remarkably.

A pale flea-beetle, *Systena blanda*, has been for some years rather a common species on a great variety of plants, both cultivated and uncultivated, and on one occasion within my experience it did some damage to beans; but it has never proved anything really serious. Near Bridgeton, in Cumberland county, it increased in a remarkable way during the present year and became destructive. Almost every field of carrots was absolutely and completely destroyed by these insects, the young plants being eaten down to the ground as soon as they appeared above it. Young beets suffered to a less extent, affording a much larger leaf surface for the pests to feed upon. Melon vines were more injured by them than by their usual foe, the "striped beetle." Even the weeds were infested, and pigweed was an especial favorite, the leaves being riddled and the plants in some instances killed. If we could induce this insect to confine its attacks to the pigweed we might become reconciled to its increasing numbers.

The "strawberry-weevil" has been troublesome in Delaware and southward for two or three years past, and has been studied by Prof. Beckwith and by Dr. Riley. The species has been collected in this State, but up to the present year has not been known as injurious to strawberries. This year, however, it did some injury both at Bridgeton and Vineland, in Cumberland county, and there is a possibility that there may be increasing trouble for some time to come. The strawberry has, in this State, been quite remarkably free from insect attack, and it would be much to be regretted if this crop should also become one for which the farmers are compelled to fight with the insect pests. There is not, unfortunately, any method of procedure which can be recommended to prevent the spread or appearance of this insect, and we can only hope that the same force that influenced its increase will also again cause its disappearance. That this hope is not without a reasonable base in this particular instance, is proved by the fact that a few years ago I found the insect excessively trouble-

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some on Staten Island in one year, while in the following years there were few or no specimens appearing.

The spread of the "pear midge" in this State is a subject that of course demanded attention, and I have been able to ascertain that it has reached Monmouth county. I found a number of infested pears on a Lawrence tree near Port Monmouth, and had it reported from a number of new orchards in the vicinity of New Brunswick. How much further it has extended I have not been able to ascertain, and one reason for that may be, that the Lawrence set very heavily in most localities during this season, and quite a considerable percentage might have been infested without attracting the attention of the farmers. It is also within the bounds of possibility that there was no very great spread during the present year, because the excessive number of blossoms furnished an abundance of opportunities for the midges to lay their eggs, and therefore migration was unnecessary. At my suggestion, Mr. J. M. White, of New Brunswick, whose orchard became infested last season, applied a very heavy top-dressing of kainit under the infested trees, with the result that this year his orchard was practically free from the midge, while in the neighboring orchard, which was also infested last year, and where no measures of any kind had been taken, every Lawrence pear was destroyed, while many of the Bartletts were also attacked. A series of experiments made by me proved to demonstration the beneficial effects of certain fertilizers as against this insect. The details of these experiments will be given further on in the report.

Among the most troublesome insects infesting pears in other States is the pear-psylla, which has been studied in New York State by Mr. Slingerland. Up to the present year no trace of its presence has been found in New Jersey. Early in the fall of this year, I received, much to my regret, specimens of this insect from a nursery in Burlington county. In order that this insect might be recognized by growers, and that proper measures may be adopted to check its advance, if indeed an advance is made, a brief compiled description of the insect and its life history is given further on in the report.

The new asparagus-beetle which was mentioned in the report for 1892 has continued to spread in the State. I found it again in Gloucester county this season, and found also a few specimens at Bridgeton, in Cumberland county. I am informed by the Philadelphia collectors that they have taken it near Gloucester and also in the

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vicinity of Camden. Thus far the insect does not seem to increase fast enough to do any real injury, and no account will be given, attention being merely called to the matter to show that it is being studied and that the insect is spreading. One of the more difficult matters in the treatment of the old asparagus-beetle has been the protection of young plants from the attacks of both beetles and larvæ, and the application of lime has been about as effective as anything that has been tried. I saw at Port Monmouth, on the farm of Mr. Roberts, a practice that is at once simple and effective. The grubs or larvæ are very soft, slimy creatures, sluggish, and able to move on the ground at an exceedingly slow pace only. The sand in which the asparagus is usually planted becomes, in the middle of a bright day, almost burning hot, and by simply brushing the asparagus rows with a round stick so as to dislodge the larvæ and cause them to fall to the ground, they can be completely cleared. The burning sand kills the slugs long before they have an opportunity of making their way back to the plants from which they have been thrown. Mr. Roberts has found this effective practically, and I tried it experimentally. I found that the insects could be very easily dislodged from the plants upon which they were feeding, dropping quite readily where a stick was brushed over and through the foliage. I found, too, that the great majority became bloated and helpless before they had marched an inch over the hot sand, and that in a very few minutes they were dead. This proceeding is at once inexpensive, simple and effective. To obtain the best results the middle of a hot day should be chosen, and the plants should be cleared before they are tall enough to cast sufficient shade upon the ground to shelter it from the rays of the sun.

Potatoes have suffered as usual from the Colorado beetle, and more than usual from flea-beetles. In fact these little pests have become so numerous, and so troublesome during the two or three years last past, that they are really doing almost as much injury as their better-known relative. Other insects which also attacked potatoes this year were the "blister-beetles." These appeared in much larger numbers than for many years previous, and while many farmers claimed that they had never seen them before, others, with better memories, or more observing, said they were the "old-fashioned potato-beetle," which used to be troublesome before the Colorado beetle made its appearance. These blister-beetles appeared suddenly, in very large numbers, and

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remained comparatively only a short time. Fortunately we are able to give some sort of explanation for the increase of these species, and a brief account of the life history and habits of our common species appears in this report.

Cranberry insects continue to exact their tribute each year, and at the meeting of the American Cranberry Growers' Association, which I attended, there was the usual complaint of injury from grasshoppers. The apparent facts as they are observed on the cranberry bogs are so strong that many growers refuse to accept the conclusions in Bulletin No. 90, and still believe that grasshoppers rather than katydids cause the injury. To again test the matter I accompanied a little party of growers to an Atlantic county bog, where it was claimed that grasshoppers were doing serious injury. The result was only what I had expected, and confirmed in every respect all the conclusions of my published reports. Not one of the growers was able to show me a grasshopper which had eaten anything but grass tissue, and in the many specimens of which I examined the stomach contents, not a trace of cranberry seeds could be found; but on the contrary, and much to the surprise of the gentlemen, katydids proved to be very plentiful, where they had been almost unnoticed, and every solitary katydid had its crop and stomach full to their utmost capacity of cranberry seeds. It was, of course, impossible to resist the conclusion that was evident upon the face of the facts, and yet the old adage that "A man convinced against his will is of the same opinion still," proved itself true again in the present instance. So firmly fixed is this belief that grasshoppers are the authors of the injury, that even the plainest facts failed to remove it entirely. One suggestive fact came out in the discussion of this subject, and that is that a flock of turkeys had been used with excellent results, by one grower, to destroy the Orthoptera on his bogs. This is in line with recommendations made by me in Bulletin K, and offers the most promising solution of the difficulty.

Cranberry-growing is becoming an industry of some importance in Wisconsin, and recently the Horticulturist of the Wisconsin Station published a bulletin compiled from reports and bulletins of the New Jersey Stations, for the information of growers of that region. At a meeting of the Economic Entomologists, held at Madison, Wisconsin, which I attended in behalf of our Station, I learned of a very interesting point of difference in the life history of the *Teras*, in that State,

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as compared with its cycle in New Jersey. In our State the winter brood of this insect is slate-colored, while the two summer broods are of a bright orange color. In Wisconsin, it is said, the orange-colored form disappears, and only the slate-colored form is known, both in the summer and winter broods. This is interesting if not quite unexpected, and it illustrates the effect of climatic influences upon an insect. Another interesting bit of information was received from Mr. A. J. Rider, the Secretary of the Cranberry Growers' Association, who sent me a few bright specimens of the "fireworm moth" (*Rhopobota*), which were sent him from the State of Washington, where also cranberries are now grown. Inquiry showed that the plants that were set out on the new bogs were obtained from Cape Cod, Mass., and this explains at once the appearance of these insects on the bogs there. The eggs which lived through the winter were almost undoubtedly on the leaves of the plants sent to be set out, and as a result, with the new crop, its insect enemies were also introduced. This is one of those cases where prompt measures would prove effective in exterminating the insect from its new locality, and a small sum expended at the present time would mean a very large saving in the future.

The use of photography in illustrating insects and their work has occupied a portion of the time of the Entomologist, and many good negatives have been obtained. It is obvious that a good picture will be much more easily understood than any possible description, and many of the illustrations used in the reports of the Botanist as well as of the Entomologist are made from photographs taken in the laboratory. An immense advantage is gained by being able to fix permanently such insect injuries as cannot be preserved, dry or in alcohol, or which lose their characteristic appearance rapidly.

The question of legislation for the prevention of insect attack was discussed by the State Horticultural Society at their meeting in December, 1892, and a Committee on Legislation was appointed. As this matter had been studied to some extent by the Entomologist of the Station he was appointed a member of this committee to consider and prepare the terms of such a law as would prove applicable to the condition of affairs in the State of New Jersey. A full and careful examination of the legislation of other States in this matter was made, and an act was drafted which it is believed may be enforced

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whenever the public opinion in any county is in sympathy with the object of it.

Finally, a few words may be added concerning the exhibit made by the Stations at the World's Columbian Exposition at Chicago. To the Entomologist was intrusted the preparation of this exhibit, and for the purpose of obtaining material, &c., the New Jersey Commission, appointed by the Governor, appropriated a sum of $650. With this sum an exhibit was prepared which compared very favorably with anything shown by other stations. From the Chemical Department was shown a very complete exhibit illustrating the composition of milk of the leading breeds of dairy cattle, and also the amount of food required by each breed to produce a given quantity of milk, butter-fat and total solids. The exhibit made by the Biological Department was of oyster culture, and is fully described in the report of the Biologist for 1892. The exhibit made by the Entomologist was also briefly described in that report. The Farm exhibit was confined to photographic views of the buildings and of the experiment herd, each cow being separately shown, and the name as well as the register number given. In addition, views of the Laboratory and of the Station staff complete this feature of the exhibit. At the request of the Director of the Office of Experiment Stations, in Washington, the Entomologist took charge of an entomological laboratory, illustrating an ample outfit for an experiment station, and this proved not the least interesting portion of the exhibit. It is expected that the material prepared will, when returned, form the nucleus of a State collection of agriculture.

As usual, the Entomologist has been called upon for talks and lectures at County Boards and farmers' meetings, and the correspondence of his office has steadily increased. At a meeting of the County Board of Monmouth county, the subject of spraying was very fully discussed, and it appeared that most of the progressive farmers had adopted the practice; also that each year a greater number of agriculturists were coming into line, finding profit in insecticide applications. In every case satisfactory results have been obtained. A new feature in presenting insect topics before farmers' associations has been the use of the stereopticon or projecting lantern, with slides made from negatives secured at the Station, and this will add both interest and greater value to such lectures in the future.

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Entomology in the "Crop Bulletin."

As was the case during the preceding year, great advantage was gained both by the farmers and by the Entomologist from the Crop Bulletins of the State Weather Service. They were used by the Entomologist to convey a certain amount of information to the farmers, and on his part benefit was derived from the records that appeared of the occurrence of insects at different times in all parts of the State. The items published are again deemed of sufficient importance to warrant a review of what appeared during the year.

May 15th, the Entomologist announced the lines of study that he desired most to pursue, asking co-operation, and on that day reports from Egg Harbor City and from Raritan township stated that spraying had begun. On the same date, Mary H. Lee reported from Vineland, "a small, black beetle working on strawberry blossoms," and this, by the by, was the first intimation I had of the occurrence of this insect in the State.

May 22d, Mr. H. Y. Postma reported from Egg Harbor City that "caterpillars are doing much damage to fruit." Mr. T. J. Beans, of Moorestown, reports that "plants removed from hot-beds to open fields are being seriously injured by cutworms." Mr. H. I. Budd, of Mount Holly, reports that "grubworms are badly cutting off sweet potatoes, tomatoes and other plants." Mr. Henry A. Jorden, of Bridgeton, reports "some damage to strawberries by a bug, but to no extent." From Monmouth county, Mr. J. Statesir reports that "potatoes are coming up, and many bugs made their appearance during the warm days." From Ocean county, Mr. Harry M. Bunnell reports, also, that "potatoes begin to show themselves, and with them potato-bugs in good numbers."

On May 29th, the appearance of "potato-bugs" is reported by Mr. D. T. Atwood, from Bergen county; Mr. J. Q. Hoagland, of Hunterdon county; Mr. Joseph A. Yard and Mr. J. Statesir, of Monmouth county. Cutworms were marked "troublesome" from Bergen county, where they were reported as generally injurious to plants and truck. From Burlington county, they were reported both as "generally injurious" and as "particularly troublesome to tomatoes." In Gloucester county they "troubled sweet potatoes," and in Warren county they were said to be "very troublesome to corn." From Vineland, Mary H. Lee reports "apple trees are badly troubled with

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worms," in some sections. Mr. John Bellis, of Kingwood, reports that "the tent-caterpillars, and the currant-worms have made their appearance." Mr. Ketcham, of Mercer county, reports "a new insect on currant leaves, giving the appearance of blight and threatens trouble." Mr. C. M. Norton stated that at Hightstown "wireworms are very active." The "corn bill-bug" was again complained of from Monmouth county, and "flea-beetles were injuring sweet potatoes" in Salem county.

June 5th, "worms and potato-bugs" were said to be "very troublesome," by Mr. Richardson, of Beverly. The "ravages of cutworms" were said to be "the most harmful of adverse causes," by Mr. Beans, while the "webworm, bill-bugs, wire and cutworms" were said, by Mr. Budd, to be "making sad havoc with young corn and other plants." It was also said that "the black louse was destroying the foliage of shrubs and leaves of cherry trees, infesting dock and other weeds." Mr. Rodewald, of Pensauken, says that "cherry trees are overrun with insects." From Vineland, Mary H. Lee said that "farmers report great destruction by cutworms;" while at Bridgeton, "bugs are doing great damage to tomatoes." From Essex county, Mr. H. Jeroleman reports that "the weather has been greatly beneficial to all manner of insects, such as the apple, cherry, peach and plum louse; also a new louse on currants." From Hunterdon county, Mr. Dilts reports that "many complain of injury to corn by cut and webworms," and also that "cutworms are troublesome to potato plants." Mr. John W. Horn, of Mount Airy, states that "since last report corn on sod has suffered greatly from ravages of the cutworm, whole fields being completely destroyed by this pest, and replanting is absolutely necessary." From Locktown, it was reported that "webworms were doing great damage to corn, some fields nearly all destroyed." In Pennington, it was reported that "corn-planting was nearly finished, and cutworms are making havoc with early planting." From Titusville, it was said that "webworms are doing some damage." In Hightstown, there was "much complaint of wireworms and bill-bugs on corn; one field, twenty-two acres, is being furrowed and replanted for the third time." In Metuchen, it was said that "potato-bugs abound." In Farmingdale, "corn came up well, but is being eaten up by cutworms." In Ocean county, "truck is somewhat injured by numerous insects." From Paterson, we learn that "potato-bugs have appeared in large num-

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bers," and that the "cutworm is also reported in unusual numbers." In Somerset county, "corn came up poorly and what is up cutworms are eating badly." From Plainfield it was briefly stated that "insects are attacking fruit trees."

June 12th, currants were somewhat injured by worms in Bergen county; cutworms were still destructive in Burlington county, and some corn and tomatoes required replanting in consequence. So, in Camden county, it was said that "worms are still very troublesome." In Cumberland county the weather was said to be "good for potato-bugs," and in Vineland, "cutworms are very bad, and rosebugs appeared in some sections." In Essex county, both "potatoes and potato-bugs" were said to be up to the average. At Swedesboro, "sweet potatoes looked badly on account of fleas and cutworms." In Hunterdon county "the worm pests continue at the corn and are doing much damage." "Potato-bugs are very numerous; tent-caterpillars and currant-worms are numerous," while "corn planted on stubble," it was said, "escaped the cutworms and looks fairly well." In Mercer county, "corn is still damaged by worms in some sections, making entire replanting necessary;" and it was also generally stated that "insect pests are still active, and rosebugs have been added during the week." From Metuchen, it was reported that "flea-beetles by the million are eating the potatoes, plant lice abound and rosebugs have come." In Ocean county, "worms and insects were very bad," while reports from Passaic county stated that "potato-bugs are getting too numerous," and that "potatoes are having a hard struggle with the bugs."

June 19th, it was reported from Bergen county that "grapes are already damaged to some extent by the rosebug." In Burlington county, "webworms are cutting corn some." In Camden county, "insects are said to be not as numerous as some years, while from Woodbine, in Cape May county, comes the statement that "the cutworm has not been here." In Gloucester county, "sweet potatoes look bad on account of bugs, fleas and dry weather." At Mount Airy, Hunterdon county, "the cutworm was not so numerous as last week," while it was doing considerable damage to the corn at Kingwood and Readington. At Metuchen, it was said that "flea-beetles and potato-bugs are busy at work; lice infest cherry, plum and other trees; rose-bugs abound." In Morris county, "cutworms are working diligently in corn-fields." In Ocean county, "rosebugs are doing great damage

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to fruit trees," and in Passaic county, insects were also said to be "more than plentiful on all fruit trees."

On June 26th, Mr. Dilts reported from Ringoes that "corn is very uneven on account of worms and drought." Mr. Doty, from Sussex county, reports "cherries, especially the early ones, stung by insects; corn looking well where not injured by grubs, and early potatoes in blossom and lots of bugs on them."

July 3d, two reports from Cumberland county state that "worms are cutting young tomato plants." In Hunterdon county, Mr. Bellis reports that "a green worm is eating corn and doing damage in some rye-fields," while Mr. Lequear said that the wireworms are bad in corn. From Metuchen, Mr. Marshall reports "rain, sunshine, growth, joy, bugs, flea-beetles, lice, leaf blight and vigilance." From Mercer county, two reports show "injury to wheat by a greenish-colored worm; some farmers say that one-third of the crop is destroyed." In Sussex county, "onions are looking fine on uplands, but on lowlands they are greatly injured by wireworms, and are a little backward."

July 10th, Mr. Beans reports from Burlington county that "many propose early threshing because of the grain moth." From Hunterdon county three reports complain of a worm eating the grain, and Mr. Hoagland states that "this worm has done great damage to wheat; from one to five kernels in each head partly eaten." "The drought of two weeks ago seems to favor worms." Web-caterpillars were said to be "quite numerous," by Mr. Fleming. From Mercer county Mr. Ketcham reports that "webworms disappeared when the corn hardened; but did great damage." Mr. Blackwell stated that "the damage to wheat by worms, and of salable corn, will amount to nearly one-tenth of the crop, the visible damage being in the cut grains." "The wheat-fields look as if bran had been sown." From Warren county it is reported that "corn has not fully recovered from the ravages of the cutworm."

July 17th, Mr. Beans again reports that "some wheat is threshed directly from the fields." In Cumberland county "the tent-caterpillar is troubling fruit trees very much." In Essex county is was said that "the caterpillars are not eating the grapes this year like they did last, and there will be an abundant yield of fruit." From Hunterdon county Mr. Bellis reports that "the web-caterpillar is doing some damage to fruit trees," and Mr. Lequear states that "potato-bugs are

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not so numerous; no rosebugs; but some fields of corn are hurt by a slender, brown worm without web." In Passaic county the potato-beetle only was complained of, and in Warren county it is said that "buckwheat is nice, where it was sown in corn-fields, after the worms destroyed the corn."

July 24th, Hunterdon county reports that "canker-worms seem to have stopped webbing," and from Middlesex county corn is said to be "uneven, and in many places worms have troubled it so that most fields are spotted."

July 31st, Hunterdon county reports that "some are threshing wheat and report a poor yield, owing to the ravages of the army-worm." In Ocean county "grasshoppers are doing much damage to newly-planted cabbage;" "vineworms are eating the leaves of field corn worse than last year;" and "it is reported in Jackson township that the fireworm is at work on the cranberry bogs."

August 7th, Bergen county reports that "sugar corn is being injured by the grubworms." In Ocean county it is said that "the cool weather has driven away grasshoppers," and that "the white butterfly which flits around cabbage has not so far made its appearance."

On August 4th there is no direct report of injury; but Mr. Bunnell reports from Toms River that "fruit is faulty, owing to the indifference of farmers in spraying." From this time to the end of the season, weather conditions were such that the damage done by them overshadowed everything else, and there seemed to be no further reports of troubles from insects. The cyclonic storms, heavy rains, following a period of severe drought, probably caused as much injury in the course of two or three weeks as insect attack did during the entire year.

The Pear Midge.

(*Diplosis pyrivora*, Riley.)

In my report for 1891, I first gave an account of the appearance of this insect in New Jersey, and concluded, from the observations made, that the insect had been within the State limits for some time. I gave on that occasion the history of the insect, so far as I was acquainted with it, and gave also a brief account of its life cycle, with some sug-

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gestions as to the character of the measures to be taken to control its spread. Since that time this insect has been under close observation, and I have watched its increase and spread with interest, and with the object of discovering, if possible, a reliable remedy or method of checking its advance. During the present year I have continued these observations, and have also made a series of experiments that were indicated by my previous studies, and these experiments have resulted quite satisfactorily. As the insect had already reached New Brunswick two years ago, I had a good opportunity for observing it; and as Mr. White, in whose orchard it made its appearance in small numbers, was quite willing to adopt any suggestions made by me, I had an excellent chance to test, in a practical manner, such suggestions as seemed theoretically indicated. The field experiments thus made resulted quite as successfully as did my laboratory experiments, and the midge was practically exterminated from Mr. White's orchard. During my various excursions to different parts of the State, I kept a close lookout for signs of the midge, and found that at Port Monmouth, two Lawrence trees, in an orchard not far from the railroad station, were infested by midge larvæ. I found, also, that the insect had made considerable spread in the vicinity of New Brunswick, and that many orchards in which it had not been previously noticed, were badly infested during the present year. In 1892, Mr. White's orchard showed a considerable number of trees of the Lawrence variety, on which midge-infested fruit was found, and as stated in my report for 1892, the adjoining orchard was very badly infested. At my suggestion Mr. White gave his entire pear orchard a heavy top-dressing of kainit, applying it under the infested trees at the rate of over 1,000 pounds to the acre; but of course this proportion was not kept up in other parts where the midge had not been noticed. Early during the present season, when the pears were of a size sufficient to show the presence of the midge, I made a very close examination of Mr. White's orchard and that adjacent to him and the result was quite remarkable. Lawrence pears had blossomed and set very heavily; but in the neglected orchard I failed to find a single fruit that was not infested by midges, and so abundant were these creatures that they overflowed to the Bartletts and to other varieties in this orchard. On the other hand, in Mr. White's orchard, the most careful search discovered only two infested pears and those at the points nearest the old orchard. The exemption

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was really most astonishing, because not fifty feet from one corner of his orchard was a Lawrence tree full of fruit, every solitary one of which was full of midge larvæ. Of course trees so infested were a distinct menace to Mr. White's orchard, and it gives me pleasure to say that it needed only a fair representation of the facts to induce the owner of the trees to consent to their being stripped of all fruit in order to destroy the larvæ contained in it. I attributed the exemption enjoyed by Mr. White entirely to the application that he had made at my suggestion; but in order that the matter might be more fully tested I carried on a series of laboratory experiments, material for which was easily obtained from the infested orchard on June 10th. Between 200 and 300 specimens of infested pears were collected; a portion of them were placed in a breeding-jar for future use and for such experiments as might be required, while the balance was divided among eight one-quart jars, half filled with sand. The pears were distributed among these jars with the idea of getting a nearly equal number of midges into each, and a rather careful selection was made of the specimens to that end. These jars were left undisturbed, except that the sand was occasionally moistened with water, until August 3d. At this time the jars were all carefully examined, and it was found that from most of the pears the larvæ had made their exit and had burrowed underground a short distance, although none had, at that time, formed cocoons. Quite a number of the pears, however, had neither decayed nor cracked open and on cutting into these the larvæ were found inside, apparently in good condition. All such pears were cut open and replaced in the jars, the abandoned specimens being thrown away. Two jars were selected as checks and set aside, receiving no application of any kind. In two other of the jars a small quantity of nitrate of soda was spread dry upon the surface of the ground, to represent in the one case a fair top-dressing under ordinary field conditions, and in the other a heavy dressing, the quantity in the second jar being exactly double that in the first. The amounts were not weighed, as they were too small. Two other jars received muriate of potash, about the same quantity as in the case of the nitrate, and here also one jar received exactly double the quantity placed in the other. A third lot of two jars was treated with kainit, the amount of kainit applied in jar No. 1 being about the same as the amount of muriate applied in jar No. 2, while in the second kainit jar twice as much was applied as was contained in the first. These

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eight jars received at intervals small amounts of water, sufficient to keep them moist, until October 6th. On that day all the jars except one of the checks were examined.

The check-jar which was first examined showed numerous specimens of the larvæ in the sand which had not formed cocoons, and all of these were alive and apparently perfectly healthy. There were also a very large number of cocoons containing unchanged larvæ, and these all seemed to be healthy and in condition to transform next season. In none of the other jars examined were there any living larvæ lying free in the soil, although here and there a few dried and shriveled specimens could be found, and in none of the other jars was there anything like the number of cocoons found in the first examined.

Jar No. 1, muriate of potash, found no free larvæ, but quite a number of cocoons; in bulk, perhaps, four-fifths as many as were found in the check lot, but in these nearly one-half of the larvæ examined were dead.

Jar No. 2, containing muriate double in quantity to that contained in No. 1, showed no free larvæ, and of cocoons about as many as in the first lot; but of the larvæ within the cocoons about three-fourths were dead.

Jar No. 3, containing nitrate of soda a small quantity, had no free larvæ, and of cocoons in bulk about two-thirds as many as in the check lot; but in the cocoons, so far as they were examined, not ten per cent. of the larvæ were alive, and the very great bulk of them were dried and shriveled.

Jar No. 4, containing nitrate of soda, double the quantity, had nearly as many cocoons as in the preceding; but certainly not more than five per cent. of the larvæ within these cocoons were alive.

Jar No. 5, containing kainit, a small quantity, had no free larvæ, and of cocoons about two-thirds of the check lot, or about the same as in the case of the nitrate; but of living larvæ there were less than three per cent. within the cocoons.

Jar No. 6, containing kainit, double in quantity to that in the preceding jar, had cocoons in bulk equal to less than one-third of the check lot, and I found not a single living larva in the cocoons examined by me. That is to say, not one-third of the larvæ in the jar ever formed cocoons, and those that did, seemed, all of them, to be dead.

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It may be said that the examination of the jars was made as follows: The entire contents were dumped into a large pan and water was added. The pan was then shaken carefully, the dirty water with the loose material floating in it was poured off and more water was added until it remained clear. The sand was then gradually washed out, and there remained only the insect larvæ and their cocoons. These were then transferred to narrow vials of exactly the same size, in order that a comparison might be readily made, and then twenty specimens of each lot were examined, in order to ascertain the proportion of living larvæ within the cocoons. The balance of the material remaining in each vial was preserved in alcohol for any further or future examination that might be deemed desirable. Earlier in the season, a small portion of the pears set aside for general purposes were selected out in order to test the effectiveness of chloride of magnesium. The larvæ were placed in a little dish containing sand, which was thoroughly moistened with the solution of one-fourth of an ounce of the chloride in sixteeen ounces of water; twenty-four hours afterward the insects had burrowed to the bottom of the dish and were showing no signs of injury. As the sand was dry, clean water was added; and in yet twenty-four hours thereafter the insects were alive and apparently healthy. Again the sand was moistened with the solution and again it proved ineffective. A pinch of kainit was put on the surface and left to be dissolved by the moisture already in the sand, and twelve hours thereafter the insects were dead or dying.

From Mr. White's experience, and from the results of the experiments above detailed, I feel justified in concluding that we have in kainit, used rather heavily in fertilizing quantity, an efficient remedy for this insect. The application should be made under the trees as a top-dressing at any time after the midge larvæ have left the infested fruit. This means any time in the latter part of June, or somewhat later in the season. I would recommend the application being made before or immediately after a rain, early in July.

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Life History.

It may be of advantage to repeat, briefly, the life history of this insect, for the benefit of those who may not have a copy of the report for 1891. The midge itself is a small, mosquito-like fly, less than one-eighth of an inch in length, with a slender body and very long legs. Its appearance is very well shown in Figure 1, *a*, which shows the female from the side. This midge makes its appearance very early in the season, at about the time the pear blossoms are fully formed,

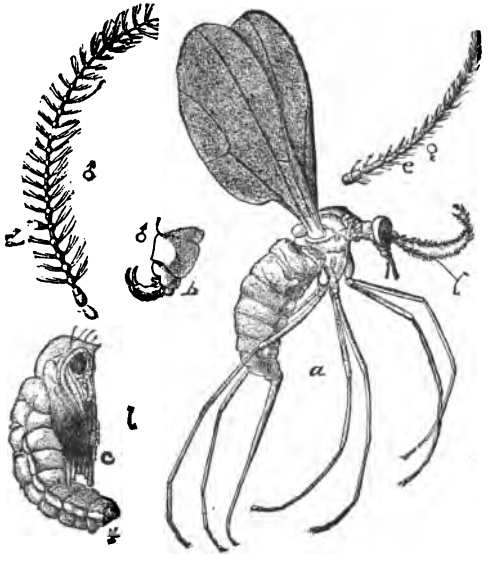

Fig. 1.

DIPLOSIS PYRIVORA.

The pear midge: *a*, the mature fly, female; *b*, tip of abdomen of male; *c*, the pupa; *d*, the male, and *e*, the female antenna. (After Riley.)

and the eggs are laid by means of the long ovipositor in the opening flowers, in the buds, or sometimes, perhaps, in the young fruit. The prime favorite with these insects is the Lawrence, and where this is available in sufficient numbers, all other varieties seem to be exempt. The eggs are laid in masses of from ten to thirty, and sometimes it appears as if more than one specimen had oviposited in the same pear; at all events forty or fifty larvæ are not unusual in a single fruit. Soon after the fruit has set, the eggs hatch, and little, yellow or

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orange-colored, footless grubs make their appearance. These grow and feed upon the substance of the young fruit around the seed capsules. Early in June, when the pears are about from one-half to one inch in diameter, they stop growing, and on examination are seen to present a rough, knobby look, sometimes appearing only unusually round. With a little experience, it is possible to pick out an infested pear with absolute certainty in almost every instance. Fruit that is once infested is hopelessly lost. There is no way of reaching the larvæ while they are feeding, and the only thing that could possibly be done is to strip the tree and destroy the fruit itself. Indeed this is advisable, where the percentage of infection is very large. About the middle of June, when the larvæ are full grown, the pears begin to decay. If they are opened at this time, it will be seen that the entire inside is blackened and eaten out, and, usually after a rain, the pears crack open and the midge larvæ wriggle out and allow themselves to fall to the ground. Sometimes they crawl out to the surface of the pear and even upon the branches, especially if the latter are wet. Sooner or later, however, they draw themselves up, bringing the tail close to the head, and then give a spring, which launches them into space and usually lands them on the surface of the ground. They make their way a short distance underground almost immediately, and there they lie, resting quietly, during the balance of the season, without undergoing changes of any kind. In September or early in October they spin a thin, silken cocoon to which grains of sand are attached, and in this cocoon, at the distance of about one inch underground, the insects remain until spring. Very early in the season the larvæ change to pupæ and these transform to adult midges during the first warm days. There is absolutely no time in the entire life history of the insect when there is any opportunity of reaching the specimens so as to save infested fruit. The only chance of reaching them is when they are underground, and I think I have shown how they can be reached there satisfactorily. A very good advice is, after the application of the fertilizer, frequent cultivation, which would

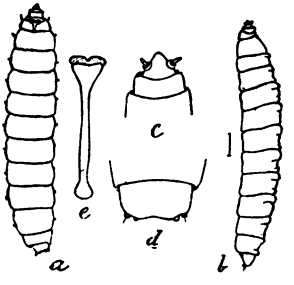

Fig. 2.

Pear midge larva: *a*, from above; *b*, from side; *c*, head; *d*, anal end of larva; *e*, the breast bone.

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expose the insects or would bury them deeply and would also give the fertilizer additional opportunity to act. Cultivation just before the kainit is applied is also a very good practice, because it does not then feed the weeds or grass, and it is more certain to reach the midges or their larvæ.

The Pear-Tree Psylla.

(*Psylla pyricola*, Forst.)

This insect, which has made its appearance in our State during the past season, is one of the most dreaded by growers in New York State and in Connecticut. It is by all odds the most dangerous enemy to pear trees in that section, and it is to be dreaded in our own State as second only to the midge. Heretofore, the insect has not been found in New Jersey, and it has been considered that the State lies somewhat out of its geographical range. Commerce has done so much to spread insects that we never can tell exactly where known pests will next make their appearance; sometimes great stretches of territory are covered in one year, or an insect may jump from one part of the country to quite another without touching intervening points. It is in this way that the present species was introduced into New Jersey. Pear trees, buds or grafts purchased in either Connecticut or New York State harbored this insect in some one of its forms, and these developed and multiplied in their new home after the fashion of such pests. The insect is so important in New York State, and has been so injurious there in past years, that it has formed a subject of close investigation at the Cornell Experiment Station, and from Bulletin No. 44 of that Station most of the facts here given have been taken. I have, however, myself, collected the insect in Connecticut, and had personal opportunity of seeing the damage caused by it.

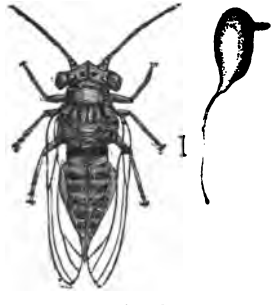

Fig. 3.
Adult pear-psylla and egg.

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Classification.

The insect is one of the true bugs, or Hemiptera, and belongs to the family *Psyllidæ*, commonly known as jumping plant-lice, from the leaping habit of the adult. The *Psyllidæ* belong to the same section of the bugs as do the true plant-lice, and they have the same feeding habits, puncturing the leaves and twigs of the trees and sucking the sap.

The Injury Done.

Among the first indications of the presence of this insect in large numbers is the noticeably lessened vitality of the trees early in the season. Old trees especially put forth but little new growth. Where new growth starts, in many cases the shoots begin to droop and wither in May, as if from loss of sap. A little later, whole trees may put on a sickly appearance, the leaves turn yellow and the fruit grows but little. By midsummer the leaves and half-formed fruit frequently drop from the trees. In many cases twigs, branches and trunks may be covered with large quantities of a sweet, watery fluid, similar to the honey-dew excreted by the plant-lice. At first this honey-dew is clear, but very soon a black substance appears and spreads rapidly all through it, causing a disgusting, blackish appearance, as if the trees were covered with smoke from a factory. This black growth is a fungus which grows luxuriantly within the honey-dew, but does not attack the tree. It forms, however, with the honey-dew, a coating which must close many of the breathing pores of the leaves and thus materially affect their healthy growth. In some cases trees appear as though treated with a thick coating of paint. Distinct and prominent as are the effects of their work, the insects themselves are not so easily seen, especially in the immature or larval stages.

The Appearance of the Insect.

The immature forms are shown in Figures 4 and 5, illustrating a full-grown nymph from above and below. When first hatched they are of a translucent yellow color, hardly visible to the naked eye and rather more than one-hundredth of an inch in length. They grow rapidly, however, and undergo, gradually, changes in color and form until they measure about one-twentieth of an inch in length.

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They are then oval in shape, of a general blackish color, often tinged with red, while the eyes are of a bright crimson. Very conspicuous features are the large wing-pads on each side of the body. The body itself is very much flattened, being only one-fifth as thick as long. The adult insect is shown in Figure 3, and strikingly resembles the cicada or harvest-fly in minature, being only about one-tenth of an inch in length. When at rest the two pairs of large, nearly-trans-

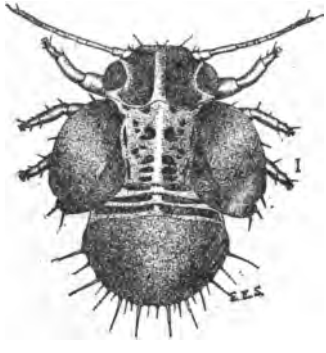

Fig. 4.
Full-grown nymph, dorsal view.

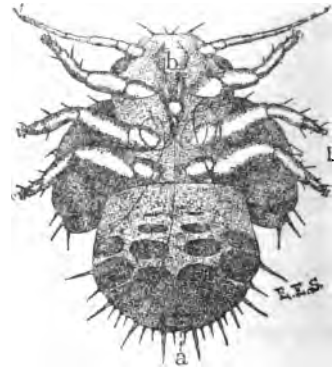

Fig. 5.
Full-grown nymph, ventral view: *a*, anus; *b*, beak.

parent wings slope roof-like over the side of the body. The general color is crimson, with broad black bands across the abdomen. The legs are thickened to aid the insect in leaping.

The Life History.

This insect winters in the adult stage, passing that season hidden under pieces of loose bark, or in crevices, or in cavities formed by the bark growing about the scar of a severed limb, and both sexes are present in these hibernating forms. Very early in the spring the insects make their appearance on the twigs and branches and soon begin to copulate. By the middle of April a very large proportion of the eggs have been deposited, and soon after, or about the beginning of May, the hibernating adults disappear. The eggs are placed in the crevices of the bark or in old leaf scars, about the base of the terminal buds of the preceding year's growth, and some also about the side buds near the terminal ones. They are usually laid singly,

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but rows of eight or ten are sometimes found. The eggs are scarcely visible to the naked eye and are but a little over one-hundredth of an inch in length. They are elongate, pear-shaped, smooth, shiny and of a light orange color when laid, becoming darker before hatching. A short stalk on the larger end attaches the egg to the bark, and a long thread-like process projects from the smaller end. According to the temperature, the eggs hatch in from eleven days to one month. Immediately after emerging from the egg the larva seeks a suitable feeding-place and is soon at work sucking the sap with its short beak, which appears to rise from between the front legs. The favorite feeding-places are in the axils of the leaf petioles and stems of the forming fruit, and there they gather in close clusters. If very numerous they gather on the under side of the leaves, along the midrib. They move about very little, sometimes becoming quite covered with their own honey-dew. If disturbed they crawl about quite rapidly. The adult appears about one month after hatching from the egg. This adult has quite different habits. The strong legs and wings enable it to spring up and fly away with surprising quickness upon the slightest unnatural jar or the near approach of the hand to its resting-place. They feed upon the juices of the leaves and tender twigs of the trees, and seem to have no favorite feeding-place. These summer forms fly readily from tree to tree, and could easily be borne by winds for long distances, while the hibernating forms are quite sluggish in their movements and are readily captured when found.

Three or four days after their transformation, the adults of the early summer brood copulate, and egg-laying begins for another series. These eggs are usually laid singly, sometimes several in a row or group, not on the twigs, but on the under side of the tenderest leaves, among the hairs near the midrib or on the petioles near the leaf. These eggs, under the warm summer temperature, hatch in from eight to ten days, and the same round of change from the larva to the adult stage is again gone through. After midsummer, this brood, in turn, lays its eggs, and from these eggs hatch the insects which pass through the winter. In New Jersey, I have this year found specimens still in the pupa state, although the majority were already winged, on the 21st day of October, and before the end of the month all the pupæ transformed into adults. These adults do not pair, but seek winter quarters, as already described, and live through

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until coaxed out by the warm days of early spring, when they copulate, lay eggs and the life cycle, already described, is entered upon. It will be readily noticed that owing to the number of broods in a single year, the insect has the possibility of increasing at an extremely rapid rate, and that in a comparatively short time an orchard could be completely overrun by them, and they would then be ready to spread in every direction.

The Insect in New Jersey.

The first notice of the occurrence of this insect in our State reached me through Prof. Beckwith, of the Delaware Experiment Station, who found it in one of the large orchards and nurseries near the Delaware river. Personal investigation showed that the insect was moderately adundant in one orchard, and that it infested about all the varieties of pears there grown. Bartletts, Keiffers, Lawrence, Le Conte and several other varieties were about equally attacked, though more specimens were found on those varieties which held their leaves longest. In a closely-adjoining orchard, belonging to the same parties, only a very few specimens were found. From the history of the insect, as I was able to learn it, I think it probable that specimens were introduced on trees obtained from New York State, and that certainly one, and probably two, years have passed since the insect was introduced. There is every reason to believe that it is still confined to this one locality, but there is also very great danger that if the winter of 1893–94 proves to be one favorable to the insects—that is, a moderately hard one—they will begin to spread in spring just as soon as the first brood matures. It behooves the fruit-growers of the section along the Delaware river between Burlington and Camden to keep a close watch for this insect, and to be ready to take active measures immediately upon its discovery.

Remedies.

From the fact that the insect hibernates upon the trees during the winter we have an opportunity to take measures against them during a long period of time. I would recommend that during a mild spell all the rough bark of the trees be scraped off and burnt, and that the trunk and larger branches of the trees be thoroughly washed with a strong

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solution of whale-oil soap, say one pound in four gallons of water; this mixture to be applied with a brush so as to get into all crevices and irregularities, and particularly into scars and holes, if any there be, in the tree. On the smaller branches where the bark is smooth and even, the wash need not be applied, for there is little chance of there being any specimens in such localities. In the spring a close watch should be kept upon suspected trees, and if any specimens are noticed on the buds, young leaves or in the places previously mentioned, the trees should be treated to a liberal application of the kerosene emulsion diluted fifteen times. Where an orchard is known to be infested the spraying should be made, even if no insects are noticed, and it should be done before the pear blossoms open and as soon as the leaves are well developed. It is important that this spraying be done while the insects are in the larva state, for the adults fly so readily that very few of them would be reached by the spray. The best time to make the application is soon after a heavy rain. I am inclined to think that our State is a little out of the normal range of this insect, and that if active measures are taken it may be possible to exterminate it entirely. At all events this is another case which proves the importance of a very careful examination of all plants that are imported from other sections of the country, for it is a great deal easier to import pests than it is to get rid of them after they have once obtained a foothold.

The Wheat-Head Army-Worm.

(*Leucania albilinea*, Hbn.)

In the general review, this insect will be found mentioned as one of the unexpected appearances of the season, and in the extracts from the crop bulletins there will be found a very fair statement of the distribution of the insect. As soon as the first complaints were received, I wrote at once to the gentlemen sending the reports, asking them to send me specimens, as well as an account of the extent and character of the injury done. As is usually the case, most of the growers claimed that here was something that had not been previously known to them, and in almost every instance it was stated that the

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insects had not been noticed until the grain was nearly ready to ripen.

July 6th, Mr. John W. Lequear, of Frenchtown, sent me a specimen which he "found on the heads of wheat, gnawing into the grain and littering the ground like wheat bran," and his question was, whether or not they were army-worms.

July 7th, Mr. John Quick, of Beverly, wrote that when he first saw them the wheat was in milk, and the milk from the injured grain would run down the stems. He thought they would stop eating when the grain got hard, but, in his opinion, they ate it more in shock than standing; he found them eating in the middle of a sheaf, and he spoke of the ground being covered "as if there had been bran sown over the field."

July 8th, Mr. John Bellis, of Kingwood, wrote that the specimens were first seen about two weeks previously, and that they do not infest any other plants, so far as he knew. He states further that he found them feeding on the grain in the wheat and rye and on the seeds in the timothy. He estimates the damage to each at about three per cent., and finds that they are on the decline. He also spoke of the ground being covered with bran. On that same date Mr. S. B. Ketcham, of Pennington, wrote me that at that time the insects had disappeared, and that they were first noticed on June 23d. Sometimes, he says, there were two on one head, and they usually ate from three to six grains on a head. Some of the ripened grains are only about half eaten. He speaks of their resemblance to the army-worm, and again mentioned the fact that the ground appeared covered with bran. From Mr. J. Blackwell, of Titusville, I received further specimens, with the statement that the insects were nearly all gone.

July 12th, Mr. John Bellis again wrote, stating that his previous estimate of the damage done had been too low, and that from conversation had with the farmers of the vicinity, he concluded that at least five per cent. of the grain was destroyed.

July 17th, Mr. V. R. Matthews, of Ringoes, sent me specimens of the insect. He stated that on making inquiry among farmers, he found a wide difference of opinion as to their number and the injury done to the wheat. In some fields they were much more numerous than in others near by, and in some places none at all were seen. Speaking of one of his own fields, he stated that they appeared to be thickest on the side adjoining a piece of timothy grass, and adds that

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they ate nearly the entire heads off the grass along the wheat, after the wheat had been cut.

Subsequent to this date nothing was heard of the insect, and it appears that the first brood only, for some unexplained reason, had taken a notion to attack wheat, rather than to stick to their normal food plants.

Life History.

This insect is by no means a new one, and was fully described by Dr. Riley in 1877, in the ninth report on the insects of Missouri, where also it was figured. At that time Dr. Riley traced back the history of the insect to 1874, when it was injurious in Maryland and Pennsylvania. It was again troublesome in the same States in 1875, and in 1876 it appeared in Kansas, doing considerable damage. The insect is found throughout the entire Eastern United States, extending north into Canada and west to the Rocky mountains, and it is more or less abundant every year, being one of the insects which the entomologist terms "common." Normally its food consists of grasses and the seeds of grasses, and it is only under very exceptional circumstances that they attack cultivated plants, such as wheat and rye. As I have already stated, we are absolutely unable to give any reason for the sudden appearance of this insect in numbers. Their disappearance could be more easily accounted for, because, of all the specimens sent me, more than fifty per cent. were infested by parasites; that is to say, there was an increase of natural enemies corresponding to the increase of the species, and as a result it appears to have been reduced to its normal condition before the end of the season.

The first moths make their appearance in this State during the latter part of May, when eggs are laid, and the bulk of the larvæ become full grown about the time the wheat is in the milk. These larvæ go underground for a short distance, change to a brown chrysalis, and make their appearance as moths late in July or very early in August. They have much the same general habits and structure as the true army-worm, belonging, indeed, to the same genus, and the eggs are also secreted as in that species. The eggs are thrust, in single, double or treble rows, of five to fifty or more in a row, between the sheath and stalk of the grain upon which the larvæ are destined to feed. They are generally fastened slightly to the inside of the sheath.

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and are readily seen upon pulling this aside. They are thrust in sideways, compactly pressed together and are not covered with any glistening or adhesive fluid. Each egg when examined closely is found to be very soft and yielding, so that its form is fashioned somewhat by the pressure it receives from its neighbors and from the leaf. The shell is corrugate rather than granulate, is a pale yellowish and translucent when first laid, becomes slate color before hatching, and the shell is so extremely delicate that every hair of the embryo may be seen through it. These eggs hatch during the summer in from three to five days from the date of deposition. When first hatched the larva is pale, with a black head and a shiny spot on the top of the first and last joints. It soon becomes green, with a brown head, then striped with five pale and six darker lines, and after going through five and sometimes six molts it assumes the appearance shown in Figure 6. When full grown the best-marked specimens are prettily striped with sulphur yellow and straw yellow, and with light and dark brown. The head is large, straw-colored, with two brown marks from the top to the lower face.

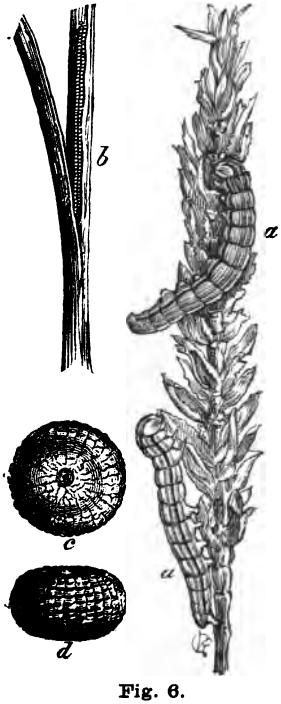

Fig. 6.

Wheat-head army-worm: *a*, *a*, larvæ; *b*, eggs, natural size; *c*, *d*, egg, top and side view, enlarged. (After Riley.)

The habit of feeding upon the grain becomes pronounced only after the larvæ are full grown, and prior to that time they feed upon the leaves and are seldom noticed. The pupa is naturally formed just beneath the surface of the ground, but frequently under weeds or other rubbish. It is of the ordinary mahogany-brown color and terminates in a stout, horny point. The larvæ acquire their full growth in from three to four weeks from hatching, those of the second brood developing somewhat

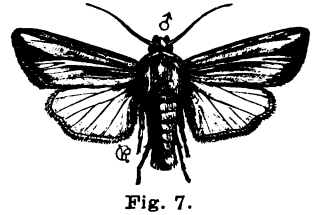

Fig. 7.

Moth of wheat-head army-worm. (After Riley.)

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more slowly than those of the first. The pupa state in the summer brood lasts from ten to fifteen days. Those formed in the fall remain underground during the winter and these are usually found deeper under the surface, say from four to six inches.

The parent moth, shown in Figure 7, has the front wings straw color, with a white line running along the middle to the outer third, and shaded with brown and purplish brown, as shown in the picture.

Remedies.

I have already stated that of the insects sent me, by far the greater proportion proved to be infested by parasites, mostly one of the Tachina flies, which had destroyed more than one-half of all those received. This indicates that under normal conditions the natural enemies of the insect serve to keep it in check, and that only abnormal conditions enable it to escape and increase in an undue manner. We are justified from the past history of the insect in believing that, most probably, next year will not see a recurrence of the same increase. But it is also well to adopt whatever measures may seem beneficial whenever it is possible to do so. During the winter the insects are in the pupa state, underground, and there they remain until well along in spring. Plowing the ground infested by them to the depth of six inches, at any time after the middle of September, will probably result in the destruction of by far the largest percentage of the specimens, while plowing the ground as early as possible in the spring will result in the destruction of a considerable proportion, at least, though this is not nearly so efficient as fall or winter plowing. After the insects are once hatched and have invaded a wheat-field, there is nothing to be done except cut the wheat just as soon as it is safe to do so and thresh it at once in order to stop the injury. If the winter of 1893–94 proves moderately mild, there is little probability that we will see any re-appearance of this species in 1894 in injurious numbers.

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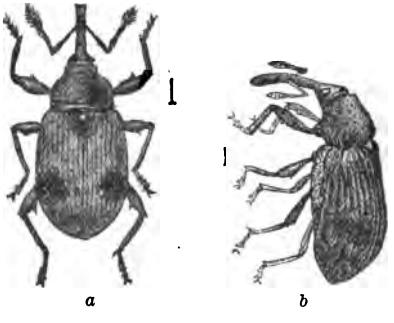
The Strawberry Weevil.

(*Anthonomus signatus*, Say.)

This insect has been reported as injurious from several localities in the southern part of the State, and mainly from Cumberland county. As yet it has not caused any serious amount of trouble, but if it keeps on increasing in number as it has done in States to the south of us, it may become troublesome in the near future. Heretofore the strawberry has been one of the few fruits that have been very little troubled by insect attack in our State, and there is no crop that will show damage from the money side more rapidly than this. The insect is a small weevil or snout beetle, belonging in the same general family with the "plum curculio," and is, in the main, black in color, marked on the wing-covers with whitish, hairy clothing, and with a somewhat variable amount of dull red. The injury done by the insect is what is generally known as a blasting of the buds; that is to say, the buds will die, shrivel up, and the blossom does not appear, or in some cases the flower will open but no berry will set. The bloom has been blasted, but what has caused the "blast" is generally not known to the farmer, unless the insects have appeared in numbers sufficient to attract his attention. By means of their beak the insects eat into the bud before it has opened, making a very small, round hole, and in this the insect lays its egg. After the egg has been laid, the insect eats into the flower stem, a short distance below the bud, puncturing it in such a way as to cause the bud to droop, turn brown and die, and afterwards, in most cases, to drop to the ground. The buds are not severed outright, as a rule, but remain for a longer or shorter time on the vines before falling. Sometimes, especially towards the end of the season, these flower-stems are punctured and killed, even when no eggs are laid in the buds. In the little bud the egg hatches, a small fleshy larva develops, and this



a *b*

Fig. 8.

Adult beetle: *a*, from above (after "Insect Life"); *b*, from side (after Riley).

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in a short time changes to a beetle. The object attained by the puncture of this flower-stem is twofold. First, the development of the bud is arrested, the outer envelope turns hard and dry, and remains folded, thus retaining the pollen and the eggs or growing larvæ of the insect. The second result is obtained when the buds drop to the ground, where they are kept more or less moist. If allowed to remain on the stem in ordinary dry weather, the injured buds would have eventually become so dry as to prevent the development of the insect within. Buds are attacked quite early in the season, in April and May, and the larvæ hatch only a short time thereafter. Mature beetles begin to issue during the early part of June, and by the end of the month all or nearly all will have developed. Soon after they become matured the beetles disappear and go into winter quarters; that is, seek shelter and hiding-places where they can remain until next spring again brings them forth to commence their destructive work. Occasionally, specimens will be found throughout the season, but these are exceptions, and we have no reason to believe that any breeding is done after the first brood matures. The strawberry is by no means the only food plant of this insect; but blackberries, raspberries, blueberries and huckleberries, and probably quite a number of other plants, are attacked. The food of the beetle is, in large part, the pollen of the buds which it punctures, and the larva itself also feeds largely, if not exclusively, upon pollen, and therefore those varieties of strawberries which, like the Sharpless, produce an abundance of pollen are the most likely to be attacked. The insect has been long known to collectors, and appears in considerable numbers each year. As a strawberry pest, it was not so well known until comparatively recent years. Some ten years ago, I met with it on Staten Island, N. Y., to which point I was sent to investigate the history of the insect by Dr. Riley, on behalf of the United States Department of Agriculture. At that time the insect did considerable damage in a few isolated localities only, and had become more

Fig. 9.

Anthonomus signatus: Spray of strawberry, showing beetles at work—natural size. (After Riley)

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troublesome during a period of two years. The year following, as I understand, it did comparatively little injury, and since that time there has not been any serious complaint from that point. For a year or two last past, complaints have been received from Maryland, Delaware and Virginia, and the insect has been studied by Prof.

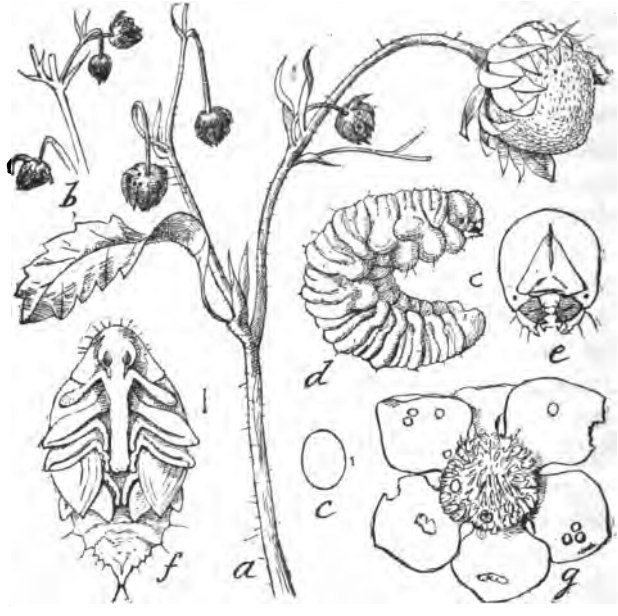

Fig. 10.

Anthonomus signatus: *a*, *b*, strawberry spray, showing work in bud and stem—natural size; *c*, outline of egg; *d*, larva; *e*, head of larva—much enlarged; *f*, pupa; *g*, open bud, showing location of egg on left and punctures made by snout of beetle on petals. (From "Insect Life.")

Beckwith, of the Delaware Station, and by the United States Entomologist. In "Insect Life," Vol. 5, No. 3, is a full account of the insect, by Mr. F. H. Chittenden, one of Dr. Riley's assistants, from which the main points of the preceding life history have been taken. From what has been observed in these States, we have reason to fear that the insect will become increasingly troublesome in New Jersey for a year or two to come, particularly in those counties in which it is now found. No real damage was done during the season of 1893; but if the same favorable conditions for its development continue, serious trouble may be looked for in 1894.

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Remedies.

From what has been said of the life history of the species it is obvious that the insect is one that is difficult to reach. There is no period at which we can hope to destroy it by means of poisons acting through the stomach. The insect eats so little of the plant itself that there would be no reasonable chance of its getting a poisonous quantity of even arsenic, were it applied as strong as it would be possible for the plants to bear. Contact poisons offer very little promise of relief. The beetles are so well protected by their outer covering that none of our insecticides will penetrate these, and their breathing-pores or spiracles are also so well protected that such substances as pyrethrum could hardly offer much chance of success. The only proceeding that has been found reasonably satisfactory is covering the strawberry beds by means of newspapers or more elaborate screens of linen or cloth of some kind. Varieties other than those that produce pollen of course need no protection; but the difficulty is that it would be necessary to have uncovered pollen-producing varieties to fertilize the others, and it would be necessary then to protect the plants until the flowers were fully opened and the pollen developed. Before the insect could injure these open blossoms, even if it attempted to do so, the work of fertilization would probably be accomplished, and by reducing the number of pollen-producing plants to a minimum the work of protecting them would be correspondingly reduced.

Farmers are advised to keep a close lookout for this insect during the season of 1894, and to notify the Entomologist of its appearance promptly.

The Corn-Root Webworms.

(*Crambus*, sp.)

Complaints of injury to corn roots by a "webworm" have become increasingly abundant for two years past in New Jersey, and were never so great as during the season of 1893. In some localities, corn was replanted two or three times before a stand was obtained, and even then the fields were frequently ragged and irregular. In other districts, the insects seemed to be entirely unknown. As a rule, the most severe injury is done early in the season, and by persistent

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replanting, as soon as injury to the hills is noticed, a stand is obtained; but sometimes the insects continue on and injure corn even when a good start has been made. On June 28th, I found an infested field near Bridgeton, in which corn was well advanced and which was badly injured. The first apparent trouble is a stoppage of growth in the plant; then it becomes deformed and frequently dies. If it is a vigorous one, it sometimes makes a new start, but remains far behind the other plants which have not been infested. The field in question and others in the vicinity had been replanted twice and, in part, three times, and I found many hills from which I took anywhere from two to six larvæ, lying in a loose web among the soil and close to the roots. They had, in each case, eaten into the stem, and in one case had actually bored into its center for a short distance. Reports of injury have come in quite sparsely, and most of my information was obtained by conversation with the farmers. The accounts given differed quite considerably, and the conclusion was forced upon me that more than one species is concerned in the injury. This is not surprising when we consider that the corn-feeding habit is not a primary one and has been, apparently, acquired within a comparatively few years, not in our State only, but in other parts of the country. Accounts of root webworms have been published in New York, Delaware, Iowa, Ohio, Illinois, Indiana and other States, and in nearly all of them injury is increasing annually.

Habits of the Insects.

Walking through grass-lands at almost any time during the summer, we note, flying up before and on all sides of us, white or yellowish moths, which soon alight again and hide in the herbage. If we approach carefully and find the location of a specimen so we can observe it, we will note that the wings are closely rolled around the sides of the body, and that it has a quite long, projecting beak or snout, which further examination shows are the palpi or mouth feelers. This peculiarity gives the insects the common name of "snout moths," and they belong to the genus *Crambus*. They are also quite frequently seen on fences inclosing the fields, and I well remember an occasion many years ago, in Illinois, when I found dozens of specimens in this way of a species I had not previously seen. If we capture a number of the specimens started up from the

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fields and examine them more closely, we will find that several species are represented, and that many of them are marked and ornamented with silver stripes and bands, and frequently also with golden lines or scales, giving the insects a positively beautiful appearance. From the situations in which they are found, the insects have also been termed "grass moths," and we will find a somewhat different set of species at different seasons of the year. Being thus, primarily, grass-inhabiting insects, it is not surprising that the injury is largely confined to fields in corn after grass.

Life History.

The life history of all the species is approximately similar. The moths make their appearance in spring, varying somewhat according to weather and temperature, but usually near the middle or latter part

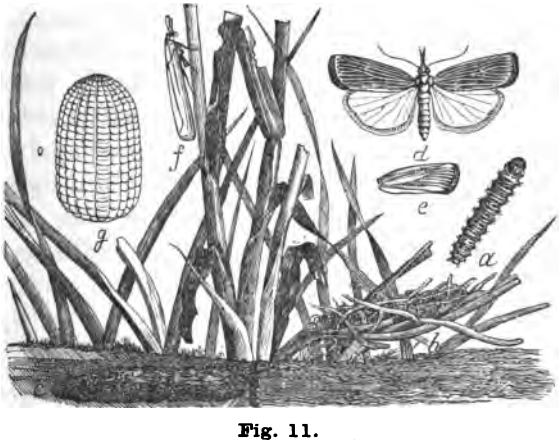

Fig. 11.

Crambus vulvivagellus: *a*, larva; *b*, web of same; *c*, cocoon; *d*, moth, wings expanded; *e*, variety of fore wing; *f*, moth, wings closed; *g*, egg, much enlarged. (After Riley.)

of May, and the eggs are laid in grass-lands at about this time, or early in June. From studies made by others, it is probable that about 200 eggs are laid by a single female, and that they are dropped among the rubbish and vegetation on the surface or are very loosely attached to the blades or stems of grass. The eggs are yellowish in color, oval in form and are beautifully ribbed and sculptured, as shown in the figure. The larvæ hatch from these eggs in from 6 to 10 days, and they at once commence feeding on the grass and very

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soon thereafter form a loose web or tube of silk—sometimes on the surface, sometimes a little below it. In the latter case they run nearly straight burrows among the roots or above them, and the feeding is done on the stalk or outer leaves, or in rare instances the crown is attacked and the plant killed. Grass will, however, support a very great number of insects without showing any apparently serious injury, and few farmers realize how great an annual loss they suffer from this source alone. The species differ quite considerably in the character and completeness of the webs or tubes made by them. Sometimes the tube is complete and quite firm, sometimes it is loose and very imperfect, and sometimes there is no apparent web at all. The larvæ vary from white or yellowish to pink or reddish or to brownish, according to age or species, and they are furnished with minute tubercles set with little tufts of bristly hair. The larva matures in from 5 to 7 weeks, forms a cocoon in the soil, sometimes at the end of its larval tube, and in from 12 to 15 days the moths issue—say early in August and probably throughout that month. Eggs are laid in August and September, again in grass-lands, and the young larva hatches in September or October, attaining its growth in part during that same year. When overtaken by winter it is half grown or more, and hibernates just below the surface in its silken tube, ready to recommence feeding in spring. As soon as the grass starts the larva also begins feeding, reaching maturity early in May or thereabouts, and thus completing the life cycle of one entire year.

Injury on Corn.

It is quite the usual practice to follow sod by corn, not only in our State but elsewhere, and, as a matter of course, whatever insects may have been in sod remain to attack corn. If the plowing is left until well along in spring there is a fair chance that the moths from the hibernated larvæ will have matured and deposited eggs, leaving an infested ground for the corn. After the corn is up and the young larvæ have hatched they of course attack whatever food plant they find, and the corn is near enough to grass to induce them to feed upon and relish it. The young larvæ construct a web, half an inch to an inch below the surface of the ground, usually winding it irregularly among the roots and stalks of corn. Hills infested by these caterpillars have the stalks when small cut off entirely or in part, the

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upper portion being frequently devoured. Larger stalks have cavities gouged out of the sides at the surface of the ground or a little above, and sometimes channels are eaten to or even in the center. The leaves also are eaten at the base, and numerous holes are scattered over the blade, sometimes with peculiar regularity, arranged in transverse rows of three to five, the rows about the length of the larva apart. Often the stalks when injured as above described decay and rot off.

Fig. 12.

Young corn plant attacked by root webworm: *a*, web of larva; *b*, cavity eaten in stalk; *c*, leaves cut off. (After Forbes.)

Mr. John W. Lequear, of Frenchtown, N. J., sent me an account of the larvæ cutting corn in his vicinity, and besides the species making the distinct web, sent me also specimens of an allied larva and "some stalks of injured corn. You will see they bore or eat holes in the stalk of corn just above its union with the root. If we scratch in these hills, we find these worms in the holes or mixed in the loose dirt, without appearance of web." The larva sent me is darker than the web-makers, but is evidently a close ally, and probably belongs to the same genus. After the summer brood of moths issue, no eggs are laid in corn-fields, but grass-lands are sought by them for purposes of oviposition.

Remedies.

These larvæ rarely occur in corn except where it is planted on sod, and hence injury could be avoided by planting some other crop between sod and corn. If this is considered undesirable, a considerable advantage can be gained by care in fixing the date of plowing. If fall plowing of the sod is feasible, this should be done early, so as either to prevent egg-laying or to starve out the larvæ already hatched, or it may be done very late, exposing the larvæ to the weather or burying deeply. If fall plowing is undesirable for any reason, plowing should be done early in spring and the ground should be left clear for two weeks, if possible. No moth will lay its eggs on

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bare ground, and if the plowing is done before eggs are laid in the sod, I should expect the corn-field to remain clear of pests. The later plowing is done, the more danger of injury. In the southern and middle counties plowing should be done not later than the first week in May, and earlier if possible. In the more northern counties, a week or two weeks later may answer the purpose.

Direct application of insecticides is not feasible as against these insects; but a very great advantage is everywhere found in favor of those using the mineral fertilizers. In adjoining farms treated exactly the same as far as cultivation is concerned, the one on which the mineral fertilizers were used was free from injury, while the other was badly infested. I would very strongly advise the application of all the necessary potash in the form of kainit, put on as a top-dressing after the field is prepared for planting, and I would expect to find good results from this practice. Fall plowing and kainit as a top-dressing in spring, will, I feel convinced, destroy by all odds the greatest proportion of the webworms that may infest the sod, and would also destroy or lessen many other pests which trouble corn during the early part of its life.

The Pale-Striped Flea-Beetle.

(*Systena blanda*, Mels.)

Flea-beetles are gradually coming to the fore as pests of the first rank, some, like those infesting round and sweet potatoes, being the most troublesome on crops infested by them. For some years past one of the larger species, measuring nearly one-fourth of an inch in length, varying from yellow to black in color and with a white or yellow stripe on each wing-cover, has been becoming continuously more common. Four or five years ago I found it injuring beans in the northern part of the State, near Washington, and I have found it since from that point to Cape May, on a very great variety of plants. In several of the Central and Western States it has appeared in numbers sufficiently great to attract attention, and Prof. Bruner, of Nebraska, considers it one of the more troublesome forms on sugar-beets.

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During the summer of 1893 this species was more abundant than ever, particularly in the southern and central counties, and it was most destructive to carrots near Bridgeton, where I had an opportunity of studying the species, June 26th, and where it had almost entirely destroyed every field of carrots. There was a severe drought under way at that time and the plants were backward; but as soon as they appeared above the surface they were attacked and forthwith eaten off. The leaves of young beets were also infested, from two to ten specimens being present on every plant; but they were more vigorous, with larger leaves, and better able to sustain the injury, no permanent damage being done. Melons of all kinds were also attacked, and in one field of cantaloupes the injury done by these creatures exceeded the injury done by the striped beetles. The beetles were not, however, confined to cultivated plants, but attacked weeds as well; purslane was universally infested, and the pig-weeds showed not a sound leaf, many of them being even killed. Corn was somewhat infested, but no real damage was done, because the comparatively small holes eaten in the blades of a vigorous corn plant could not check growth to any appreciable extent. In some of the Mississippi States the injury to corn is more marked.

Fig. 13.

The pale-striped flea-beetle, *Systena blanda*. (From Bruner.)

Life History.

Very little has been published concerning the early stages of this insect, and that is comprised in a statement made by Prof. Forbes, of Illinois, that he bred the beetle from a slender white larva feeding on sprouting corn. I am informed that since this was published, in 1886, Prof. Forbes has succeeded in working out the full life cycle of the insect, and that it will be published in the near future. It is certain, however, that in this State at least the larva feeds on something other than sprouting corn, for not the entire corn-planting of

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South Jersey could support the enormous number of beetles that appeared in June, 1893, in Cumberland county alone.

Remedies.

Owing to our incomplete knowledge of the life history of this insect, remedial measures to be taken can be only suggestive, and may not be the best when we have more information on the subject. The beetle feeds exposed on the leaves, however, and is mandibulate, chewing its food; hence the arsenical poisons are indicated and will undoubtedly be effective. This is one of those instances when a knapsack pump with an underspray nozzle, such as is herewith illustrated, is essential, and with it a large field can be rapidly and

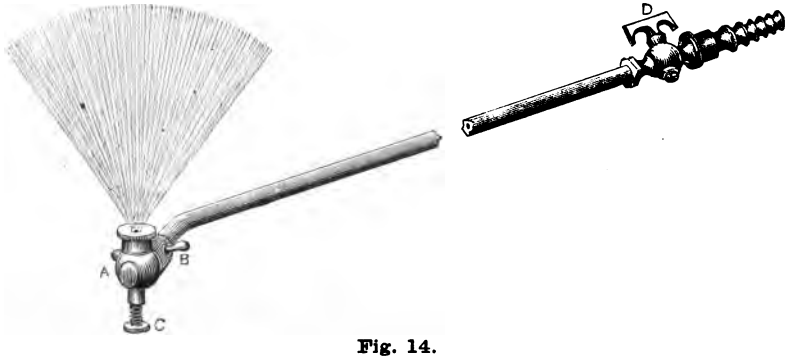

Fig. 14.

Undersprayer: *a*, nozzle; *b*, union joint, to hold the nozzle in any desired position; *c*, degorger, for clearing nozzle; *d*, shut-off. The lance is three feet in length.

thoroughly covered.* Paris green or London purple with lime, in the proportion of 1 pound in 175 gallons of water, would be sufficient. The spraying should be done as soon as the beetles are first noticed, and the weedy plants, such as purslane and pig-weed, should be as thoroughly sprayed as the crop itself.

*This lance and nozzle is made by Wm. Boekel & Co., 518 Vine St., Phila, Pa.

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The Chestnut-Weevils.

(*Balaninus*, sp.)

Chestnuts, as a crop, are not grown to any very large extent in our State; yet, there are some tracts of considerable size from which a very good profit is derived in favorable seasons. Of late years, efforts have been made by a few of our leading nurserymen to introduce some of the large varieties, such as the Spanish and Japanese,

Fig. 15.

Chestnuts injured by larva of *Balaninus*. The upper figures show the nuts with the shell removed and the cavities made by the larvæ; the lower figures show the holes from which the larvæ emerged. About one-fifth larger than natural size. (From a photograph.)

and with very good success. It has also been planned to set out a large acreage of our American varieties in the western and southern parts of the State, on land which has naturally grown this nut. The only drawback to chestnut culture is the fact that many of them get "wormy," but up to the present year the percentage of attack on the imported trees has been small and scarcely noticed. The crop of

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1893, however, was almost completely destroyed, and in the nurseries of Parry Brothers the ground was covered with huge nuts of some of their improved varieties, among which it was almost impossible to find a sound specimen. The native, uncultivated nuts were as badly infested, and in the market nearly half of the nuts proved wormy, the number of round holes visible in the shells at even a casual glance showing the extent of the injury. The increase among the insects seems to have been general, therefore, due to some favorable climatic cause, and in such circumstances little selection of varieties was made by the insects: nearly all suffered equally. According to the Messrs. Parry, the Paragon (Spanish) and Hannum (Spanish) were least attacked and nearly free from injury, while there was little choice among the others, whether native, Spanish or Japanese.

The larva causing the injury is a soft, white, footless grub, with a yellowish head, and it eats large, irregular cavities in the meat of the nut, becoming full grown when the nuts are ripe and drop, and issuing out of a round hole which it cuts through the shell.

The beetles produced from these grubs are yellowish, oval in outline, with an extremely long and slender black beak, and there are at least two species, *B. proboscoideus* and *B. rectus*, which attack the chestnuts in our State. It is of no essential importance to the farmer to be able to distinguish these species, since their habits are practically alike. Both of them make their appearance during the time the chestnuts are in blossom, say from about the middle of June to the middle of July, although occasional specimens are found later in the season. At the time of blossoming the chestnuts are fully formed, and larger than might be supposed. The envelope or burr is over three-quarters of an inch in height, soft and covered with distinct tubercles from which the prickles afterward develop. It is at this time that the eggs are deposited in the embryo nut, and to enable the insect to reach this point, the enormously long, slender beak is brought into play. This beak or proboscis is from one-half to three-quarters of an inch in length, and by its means a small hole is bored into the burr. Through this hole the egg is worked into place in the young nut. The small puncture made by the slender beak of the insect heals completely, so it becomes impossible afterward, when the nuts are ripe, to discover how the larvæ entered them. As soon as the larvæ are full-fed they leave the nut, and this may be at any time between the middle of September and the first of November. Usually a single larva is found in our

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American species, but occasionally a large nut may contain two. In the large varieties, like the Spanish and Japanese, I have found as many as six, and in most cases more than one. After leaving the nut the larvæ make their way a short distance underground, and remain there unchanged until the following spring, changing to a pupa from three to six weeks before the imago is ready to emerge. Dr. John Hamilton, of Alleghany, Pa., who has studied these species and from whose papers the above account is derived, states that a considerable number of the larvæ do not develop the first year ensuing upon their full growth, but lie over until the second year, and this is nature's provision for the continuance of the species should there be an entire failure of the crop in any one year, as sometimes happens.

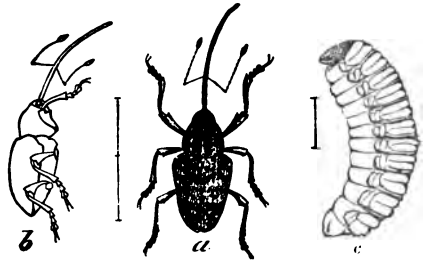

Fig. 16.

Chestnut-weevil. *Balaninus rectus*: *a*, from above; *b*, outline from side (after Riley); *c*, larva (after Packard.)

Remedies.

The life history given above shows at once that there is no period in the development of the insect when it is within reach of poisons, either those that act by contact or those that are eaten. The egg is placed safely out of reach, and the larva feeds, snugly housed, absolutely beyond danger from any application that can be made. The beetle feeds very little, and we cannot possibly cover the forming burrs with any poison that would be repellant or destructive. On small trees a great measure of protection could undoubtedly be obtained by jarring the beetles into an umbrella or on a sheet, and this would have to be done every day during the period of blossoming. In a nursery it might be feasible; but certainly not on a large scale or with large trees. After the larvæ leave the nut and go underground they are exposed to many natural enemies in the form of insectivorous animals and predaceous insects, and their numbers are materially lessened in this way. In nurseries, or where the ground is cultivated, most of them are killed by the ordinary farm practice and particularly where

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the mineral fertilizers are applied; but this again would not be serviceable in extensive groves which are not cultivated. There is really only one process that offers a good chance of success, but this would prove effectual, I believe:

First. Get rid of all wild trees in the immediate vicinity which might serve to propagate the species.

Second. Plant in the groves a majority of those varieties which experience has shown are least affected when the beetles are abundant. These varieties, according to Parry Brothers, are, in their experience, Paragon and Hannum, but they may be different elsewhere, and other varieties may be even more exempt.

Third. Plant also a fair number of the varieties which experience has shown are worst infested when the insects are not common, and which may be considered favorites, and these trees should be pretty evenly scattered in the grove.

Fourth. Just as soon as the nuts begin to drop, see that everything under the favorite trees is gathered immediately, and at once ship or destroy the nuts. The object is, of course, to get the nuts before the larvæ leave them, and thus prevent them from completing their changes. An essential element in the success in this proceeding is promptness and thoroughness in gathering the nuts, as larvæ are leaving them constantly. Indeed, good farming for nut culture demands that the crop be gathered just as soon as it is in any way possible.

By planting trees that are favorite objects of attack by the insects, we attract them to definite or known points, and by keeping the ground under these trees tolerably clean, so the nuts when they drop can be readily seen, the crop from these trees when gathered will be found to contain much the greatest percentage of the larvæ to be found in the grove, and these trees will protect the others. I would advise 10 per cent. of the trees in a grove to be of varieties most subject to attack.

Systematic early gathering of the nuts will in itself appreciably lessen the number of weevils for future years. It almost goes without saying that wormy nuts should not be thrown outdoors, but should be *burnt*. If nuts cannot be sent to market at once, they should be put into tight boxes or barrels, not necessarily covered,

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through which the larvæ cannot make their way. When the nuts are removed, the accumulation of larvæ should be destroyed with boiling water, or in any other convenient way; but never thrown outdoors, where they might get opportunity of getting underground to complete their transformations.

Beneficial Insects.

The subject of beneficial insects is, in some respects, quite as important to the farmer as that dealing with the injurious forms. As a matter of fact, the number of species that are economically important on account of the damage they do to our cultivated crops is comparatively small. There are not more than a few hundred species known as really injurious in field and orchard of the over three hundred and fifty thousand described, while the actual number of species of insects has been estimated at two millions. In the first place, only species that feed upon vegetation are apt to be troublesome to the farmer, if we except the few that are parasites upon domestic animals and birds. The whole of that exceedingly large series of insects that is predaceous, feeding upon other species and upon a variety of lower forms of animal life, is certainly not injurious, even if not always actively beneficial. All that great number of forms feeding upon all kinds of decaying vegetable and animal matter is actively beneficial, removing or changing into plant-food the forms of organic matter that might otherwise taint the air we breathe and possibly produce epidemic disease. All that immense series with parasitic habits may be counted among those that are directly or indirectly beneficial. Most of those feeding upon honey and pollen of plants are at least innoxious. The considerable number that is aquatic, and lives in one or all stages in or on the water, does no damage to the husbandman. Only those few species, comparatively speaking, that feed upon our cultivated plants, can be considered as injurious in any sense, and of those only an exceedingly small number multiply to such a degree as to require active measures on the part of the farmer to keep them in subjection. Under ordinary conditions, nature has so arranged matters that no one organized creature shall

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increase unduly at the expense of any other. Plant life and animal life are correlated in such a way that both may live, within limits that have been gradually fixed. The insect enemies of a plant are never abundant enough to exterminate it, nor are the parasites of those species that feed on plants numerous enough to exterminate them. Everything has gradually reached a point where matters balance, and so they remain, year after year, with comparatively slight variations, climatic changes causing differences occasionally, which are again balanced after a year or two, either by contrary weather conditions, by disease, or by other natural causes. According to this natural arrangement, some insects are always plentiful, year after year, and their enemies, such as they are, never reduce them below a certain point which nature seems to have fixed as the proper one.

One of the important factors that prevents the undue increase of insects feeding upon plant life, is the amount of difficulty that the insects find in securing food for themselves, or their larvæ. Insects feeding upon a plant that is not common, necessarily cannot themselves become common, and undue increase is checked by the mere fact that there is not food enough to encourage it. The female must search to find a place to lay her eggs, and if, as sometimes happens, half a dozen females find the same plant, and all lay their eggs upon it, the larvæ, when hatched, may find themselves too numerous for the amount of food, and will either devour each other, or having eaten the plant completely, will starve to death. Only in those cases where not more than a small number of eggs have been placed upon a single plant, will the larvæ come to maturity. Insects kept in check in this wise, usually have few or no parasites; because parasites for such creatures might result in extermination. Should we now make use of the plant that is ordinarily rare, cultivate it, and instead of having individuals scattered about here and there, sometimes long distances apart, produce great masses of this vegetation, we must expect that the insects feeding upon it will increase in proportionate numbers. The females will not need to search about for plants upon which to lay their eggs; they will find them ready at hand, and can get rid of their entire stock to the best advantage and without the least exertion. Should more than one specimen oviposit upon one plant, the larvæ have the power of crawling to another, and there would be little danger of starvation. Having no active

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parasites, or perhaps only a few, the insects would almost certainly become economically important and pests to the farmer. Exactly this has happened in the case of the Colorado potato-beetle, which is one of the most troublesome species that we have to deal with. This has so few natural enemies; that so far as the farmer is concerned, they are entirely unimportant. The insects feeding upon cranberries afford another illustration. Under normal circumstances they have rather a hard task to maintain themselves, while under the artificial conditions introduced by man they flourish and multiply exceedingly. It is, therefore, in many cases a direct result of man's interference with the balance established by nature when we find an abnormal increase of certain species of insects. In other cases, where plants are abundant, insects feeding upon them have a greater number of natural enemies; but the relation of the enemies and parasites to the hosts upon which they feed seems to be, after all, comparatively a fixed one, while the relative abundance of the injurious forms to food plants will be maintained year after year with only unimportant changes. If this food-plant happens to be one that is cultivated, the amount of injury caused by insects will be approximately the same annually, in many cases making it an unprofitable one to grow, unless the cultivator himself takes a hand in the matter. Such insects are the codling moth, the plum curculio, and cutworms of various species; all of which are extensively parasitized and preyed upon by other insects, but all of which are annually abundant enough to cause a very great amount of injury to the farmer. Nature makes no effort to produce perfect fruit; it confines itself to the attempt to continue the species—that is, to produce seed—and insects that do not interfere with this aim are not injurious in a natural sense, however much they may be so from the standpoint of the agriculturist. There are other kinds of cases where man's interference disturbs the ordinary balance between plant life and insect life, as for example those instances of insects imported from other countries. It is comparatively rare that with an injurious insect we import, also, all or even any of its parasites: this gives the imported forms a very decided advantage among the new surroundings, and while they may in their native home be kept in subjection naturally, in the new country they may become seriously destructive. A very marked instance of this character is the case of the cottony cushion scale, *Icerya purchasi*. This creature

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was introduced into California some years ago, without its natural enemies, and speedily became so abundant as to threaten the absolute extermination of the *Citrus* industry. One of the most brilliant experiments, so far as results are concerned, was made upon this insect by Dr. C. V. Riley, the United States Entomologist. By studying it through his agents in its native home, discovering the species that kept it in subjection there and by introducing the principal destructive agent, which was found to be a lady-bird, into this country, the insect has been reduced to the unimportant creature which it is in its fatherland, and has been all but exterminated. This is an exceptional case, and it will not do to argue from the result in this instance that we can treat other insects in a similar manner. Under ordinary conditions parasites or predaceous insects simply check *undue* increase, and this *undue* increase means what nature considers such and not what the farmer may deem the case. It means an undue increase in relation to the number of plants; and what might be a very proper number so far as natural conditions are concerned, would be in the consideration of the farmer an altogether undue quantity and a destructive invasion. It follows, from what I have said, that where nature has so regulated matters that certain insects appear in almost equal numbers each year, we cannot expect to derive any actual benefit from the presence of parasites or predaceous insects.

There is another very important matter to be considered. In the relation of insects to each other, the point looked to is only to prevent the reproduction of more than a definite proportion from year to year; but actual destruction may not be accomplished until the insects are ready to reproduce. For instance, fifty per cent. of the cutworms found in a field early in the season may prove to be infested by parasites, and none of the specimens so infested will ever change to moths that will reproduce their kind. Half of the entire brood has been practically destroyed, and sometimes even a much larger proportion; but—and the "but" deserves to be spelled with capitals—these cutworms will not be destroyed until they have reached their full growth and have done all the damage to the farmer that they could have done had they not been parasitized at all. In other words, the fact that fifty per cent. cutworms in his field are infested by parasites does not help the farmer in the least. Another case: plant lice sometimes begin to increase rapidly in the early part of the season, and soon become so numerous as to be exceedingly

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destructive; they are preyed upon by lady-birds and their larvæ, and these will eventually get the better of the plant lice. By the end of the season they will have conquered them, and so reduce their number that next year there will be only a few to start with, just as there were the year before. But in the case of many crops, this does not benefit the farmer in the least, because, before the lady-birds obtain control of the plant lice, the injury to the crop has been done, and although nature has actually preserved its balance, and next year there will be no more lice than this, yet it has been without any advantage to the farmer. Insect diseases stand on very much the same grounds; but these we need not discuss at the present time.

All this is intended to introduce and explain the statement that under ordinary conditions neither parasites nor predaceous insects advantage the farmer in the least, and he must not depend upon what nature will do for him, because nature is in no sense a friend of the farmer more than it is a friend of every other living creature. I am aware that there has been a very great deal said of the importance of parasites and predaceous insects in keeping in check injurious forms, and I would not be understood as depreciating their value in the least; all that I intend is to caution against an exaggerated belief in the efficiency of these natural agents to the exclusion of active efforts by the farmer himself. I do not mean to suggest that we cannot, perhaps, in the course of time, find a way of artificially increasing or of propagating predaceous or parasitic species; but what I mean to assert is, that under natural conditions, and without help by man, injurious insects will not be essentially reduced in number. It is, however, of very great importance that the farmer should be able to distinguish between those insects that are injurious and those that are beneficial, in the sense that they feed upon other insects, because there is no doubt that if, indiscriminately, destructive and beneficial insects are destroyed, the injurious insects in the end obtain an advantage. A farmer should also know how to distinguish friend from foe, for in too many cases

Fig. 17.

Spring-tail, *Lepidocyrtus gibbulus*.
(From Standard Nat. Hist.)

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insects are charged with injuries which they have never done, and which they could not do, while the real author has escaped discovery.

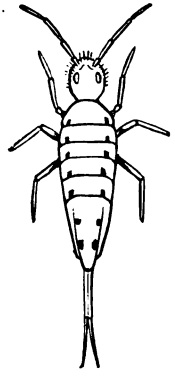


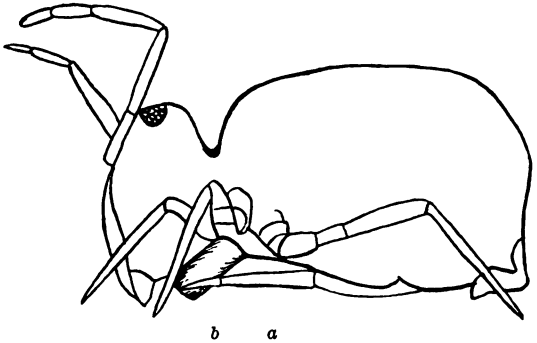
Fig. 18.

Spring-tail, *Degeeria* sp. (After Packard)

It is intended in the following pages to give a very brief outline of how some of the leading insects that may be classed as beneficial may be distinguished:

In the first place, nearly all the orders contain beneficial insects, and all of the orders ought therefore to be recognized by the farmer. This is not so difficult as it may seem at first sight, because with a very little practice it is easy to tell just where an insect belongs, and, in a general way, what its habits are. According to the Linnæan classification, insects are divided into eight orders, and this classification is a convenient one for our purpose, though it has been greatly modified by recent students.

The first of these orders is the *Thysanura*—"spring-tails" and "fish moths." The members of this order are wingless insects which undergo no transformations, the larval form being retained by the adult. The mouth parts are withdrawn into the head, only their tips being visible, and they are fitted for biting



b *a*

Fig. 19.

Papirius: *a*, spring; *b*, sucker.

and chewing soft substances. Most of the species are small insects that live in damp places, on the surface of the ground or under the bark of trees, and sometimes they will be found in enormous numbers on the surface of the soil in hot-beds, while on the other hand the

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well-known fish moth, that is frequently found in houses, lives in warm, dry places, and will serve to illustrate the largest of our forms. The order contains no beneficial insects nor, on the other hand, any that are actively injurious. Many of them have a curious spring-like appendage attached to the tail which is bent under the body, and by means of which the insects are enabled to make leaps that are enormous compared with their small size. Others have long, jointed filaments at the end of the body, which serve no purpose that we know anything about. The insects are rarely seen on plants, but where an overflow occurs millions of them are sometimes found on the surface of the water, on which they hop about as easily as on land. Certain others are sometimes found on the surface of snow, in mid-winter. The species live on dead or decaying vegetable substances and upon fungi, and in turn furnish food for a great many kinds of predaceous forms.

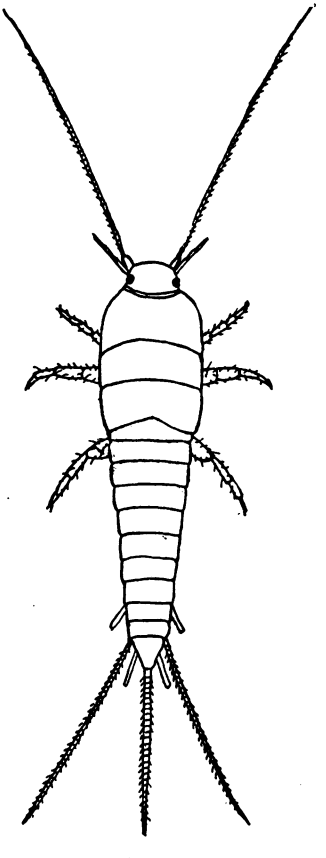

Fig. 20.

Fish moth, *Lepisma saccharina*. (After Packard.)

The second order is the *Neuroptera*. This has been divided into several distinct orders; but for our present purpose we need pay no attention to these divisions, however well founded they really are. All of the insects of this order, in the adult stage, are characterized by having four wings, which are generally in whole or in part transparent and of the same texture, and are divided and crossed by a very large number of veins, which explains the name given them, the term *Neuroptera* signifying "nerved wings." Among the *Neuroptera*, we have a very large number of forms that live during the larval stage under the surface of the water, and spend only their adult life as aërial insects. Among the most prominent forms belonging to this

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order are the dragon-flies, forming the family *Libellulidæ*, or the order *Odonata* of recent students. These are very common insects in the vicinity of streams, ponds and lakes, and as many of them are of

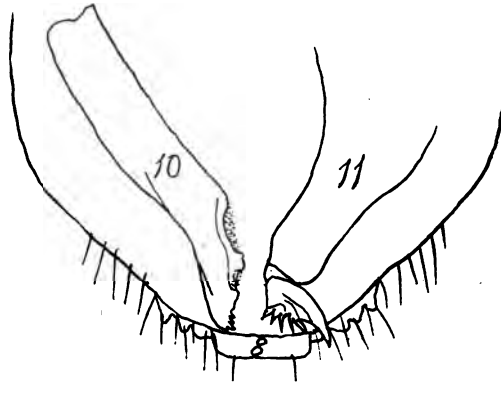

Fig. 21.

Mouth-parts of a spring-tail, *Entomobryidæ: 8*, labrum; *10*, mandible; *11*, maxilla. (After Comstock's Introduction.)

large size and fly vigorously during the daytime they are well known. They are commonly termed "dragon-flies" and "darning-needles," usually modified by the term "devils;" also, "spindles" and "snake doctors." A very popular superstition regarding them is, that they sew up the ears of those persons whom they can catch. These insects can be counted as beneficial, since they feed only upon other insects and are exceedingly rapacious. Their food, however, consists in large part of mosquitos and small flies, whence they have also been called "mosquito-hawks," and as these are not directly injurious to vegetation, however annoying they may be to the farmer, these creatures are really indifferent. We have a considerable number of species of dragon-flies and some of them are very handsome. They have a very large head, with immense eyes and a formidable mouth, but have no sort of sting, as is often supposed. They lay their eggs on or in the water or on aquatic plants, and the larvæ live out their life in that medium, feeding as hungrily upon water animals and insects as do their parents upon those of the air. They have a most remarkable mouth structure, being furnished with an extensile lip, at the end of which is a pair of sharp jaws. When it is retracted, this lip acts as a mask, and the larva looks very innocent and harmless until some smaller

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larva comes swimming along, when the mask is raised, the lip is extended and the cruel jaws close upon the hapless victim. The members of this series are easily distinguished, therefore, both in the larval and adult stages. When the larva is full grown it changes to a pupa, which is also active, and in due time crawls up the stalk of some water plant to the surface, or on some exposed stone, and there it rests quietly for a time until, finally, the skin of its back is rent and split and the dragon-fly emerges and soars off, leaving only an empty shell behind.

The *Ephemeridæ*, or "day-flies," also belong to this order, and are extremely interesting creatures, albeit of no importance to the farmer. They pass their early stages under water in lakes, rivers and streams,

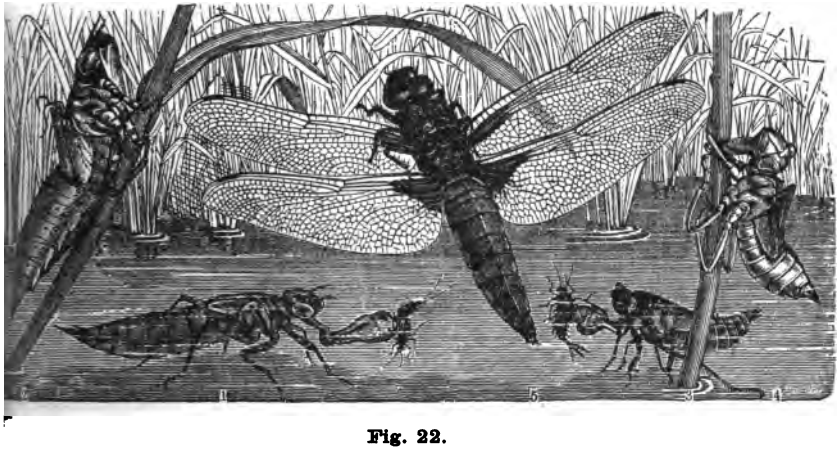

Fig. 22.

Metamorphoses of dragon-flies. 1, larva, and 2, larval skin of *Æschna*; 3, larva, 4, pupa, and 5, adult of *Libellula depressa*. (From Standard Nat. Hist.)

and make their appearance as adults in early summer, rising from the water about dusk in perfectly enormous numbers. They are strongly attracted to light, and bushels of them are often swept up under the electric lights of the cities on our Western rivers or on the lakes. They live as adults only a very short time—often a few hours only—and are easily recognized by their large fore wings, small hind wings and long anal filaments.

Other members belonging to this order are the "stone-flies," the larvæ of which are curious creatures living below the surface of the water and generally closely attached to the under sides of stones.

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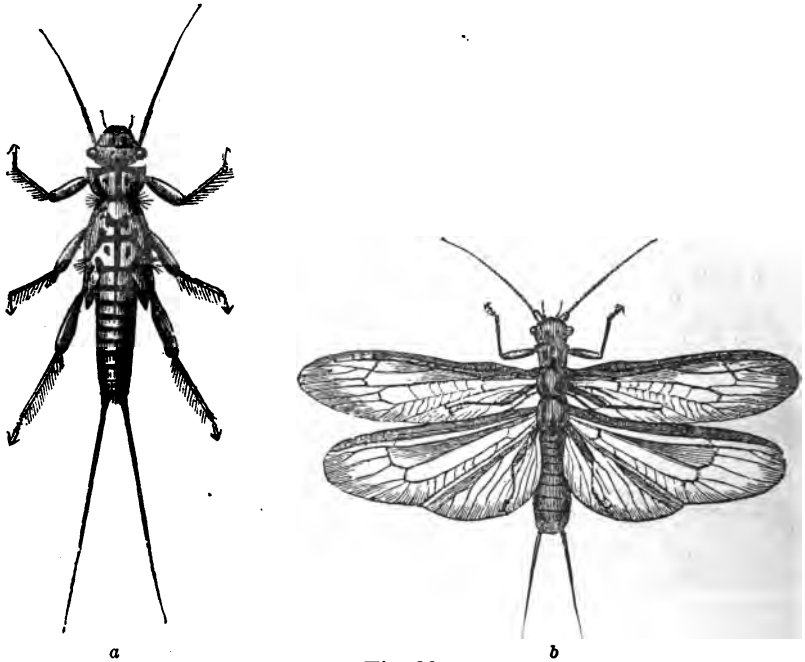
They are neither beneficial nor injurious and hence need not be more particularly described here.

Other forms of *Neuroptera* are the *Termites*, or "white ants," as they are usually called. These are very interesting creatures so far as their social habits are concerned, but are injurious rather than beneficial. In this State, however, where they occur in fields, it is generally in decaying rather than in healthy plants that they are found, and



a *b*

Fig. 23.

Stone-fly, *Perla bicaudata*: *a*, larva; *b*, adult; enlarged. (After Figuier.)

often they follow the attacks of other insects. So I have found in the roots of blackberries which had been attacked by borers and were beginning to decay, that these insects had commenced their tunnelings, and were certainly not aiding the plant in any way.

This is not the place to speak at length of the interesting habits of these creatures, but as they are so often seen it may be well to note that each colony consists primarily of workers which are not sexually developed and are unable to reproduce their kind. They are blind and shun the light, moving from place to place in tunnels constructed

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by them, and they feed largely upon dead wood and other vegetable matter, though in some cases living plants are attacked. They assist

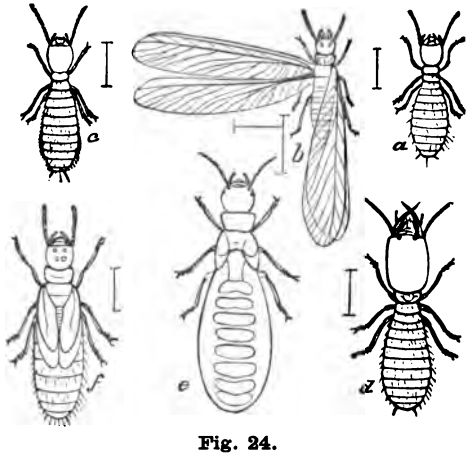

Fig. 24.

Termes flavipes: *a*, larva; *b*, winged male; *c*, worker; *d*, soldier; *e*, large female; *f*, pupa. (After Riley.)

greatly in reducing to dust fallen trees and stumps and are important factors in nature's routine.

The book lice also belong here, but have no economic importance, either as injurious or beneficial insects. They are often found in houses and are usually wingless, with long, slender antennæ or feelers and move about rapidly. They are sometimes mistaken for parasites, but are always distinguishable by their quick motions, the parasites for which they are mistaken being invariably sluggish. Other species are winged, and feed upon lichens and mosses on tree-trunks, where they are sometimes found in considerable numbers, huddled together. They have been accused, some-

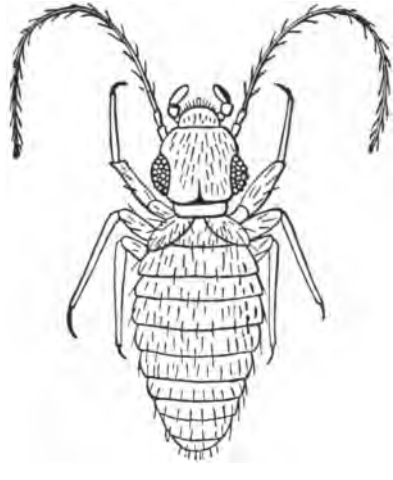

Fig. 25.

Book louse, *Clothilla.*

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times, of injuring trees, but unjustly; they are harmless and never a source of injury to the husbandman.

The biting lice also find a place in this aggregation of types. They are parasites, which live on warm-blooded animals. They infest

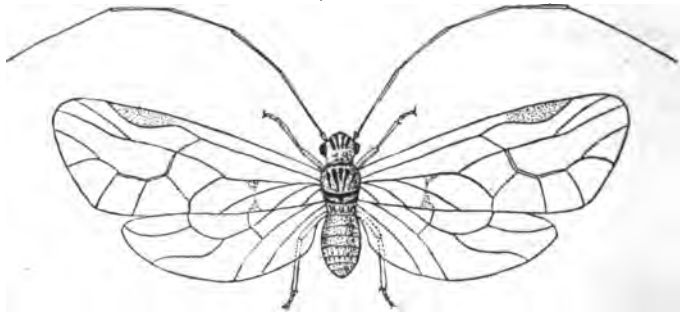

Fig. 26.

Psocus lineatus, enlarged.

chiefly birds, and on this account the term "bird lice" is applied to the entire group. A few genera, however, are parasitic upon mammals, and in all cases they feed upon feathers, hair and scales of the skin, never upon blood. The mouth parts are formed for biting only, and they have not the ability to pierce and suck, as have the suctorial lice. They belong rather to the injurious series, with which we have nothing to do at present.

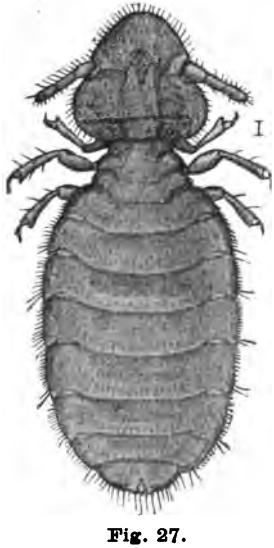

Fig. 27.

Cow louse, *Trichodectus scalaris*. From U. S. Dept. of Agrl.)

The "dobsons," belonging to the family *Sialidæ*, are other insects which in the larva state live under water, and neither they nor the adults resulting from them having any economic importauce. They are of some interest, however, to fishermen, for the "hellgrammite," as the larva is termed, makes excellent bait, especially for bass. The male of this "dobson" is a formidable creature in appearance, from its huge jaws, but it is really a most

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harmless form, and its immense mandibles are actually less powerful than the smaller but more robust structures of the female. The larva is a curious creature, living under stones in running water, and furnished with great tufts of hair laterally, which serve as tracheal gills, enabling it to get the necessary supply of air directly from the water.

A much more important group is that including the "aphis-lions" and "ant-lions," and these belong to the family *Hemerobiidæ*. They are delicate insects, as a rule, with large, though somewhat narrow, gauzy wings. The larvæ are predaceous and have a most curious modification of the mouth parts, by means of which, though they

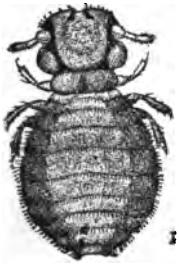

Fig. 28.

Dog louse, *Trichodectus latus*. (From U. S. Dept. of Agri.)

Fig. 29.

Sheep louse, *Trichodectus sphærocephalus*. (From U. S. Dept. of Agri.)

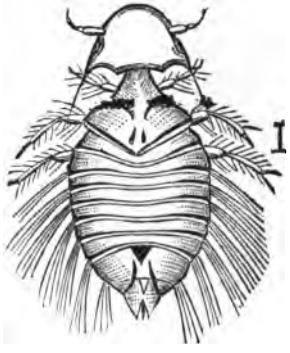

Fig. 30.

Turkey louse, *Goniodes stylifer*. (From U. S. Dept. of Agri.)

have distinct mandibles and other organs for biting, they are yet enabled to suck the juices of their victims. The mandibles, or jaws, are very long and pointed, and are grooved on the inner side. The lower jaws, or maxillæ, are also very much elongated, and are fitted to enable them to close the groove of the mandible, and thus form a complete tube through which the insect is able to suck the blood of its victim—that is to say, the mandibles grasp the prey, pierce the skin and are then simply left in the wounds that they have made, the juices being sucked through them. Plant lice form a very large part of the food of these insects, and they are, therefore, directly beneficial to the farmer. These "lace-winged flies," as they are also called, are very common throughout the summer months, and are usually of a light-green color, or yellowish, the eyes brown and very bright, which has, in some localities, given them the name of "golden-eyed

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flies." Many of the species, when handled, emit an extremely disagreeable odor, which probably serves them as a means of protection. A remarkable fact in the history of these insects is the way the female cares for her eggs. When about to oviposit, she emits from the end of her body a minute drop of a tenacious substance. This

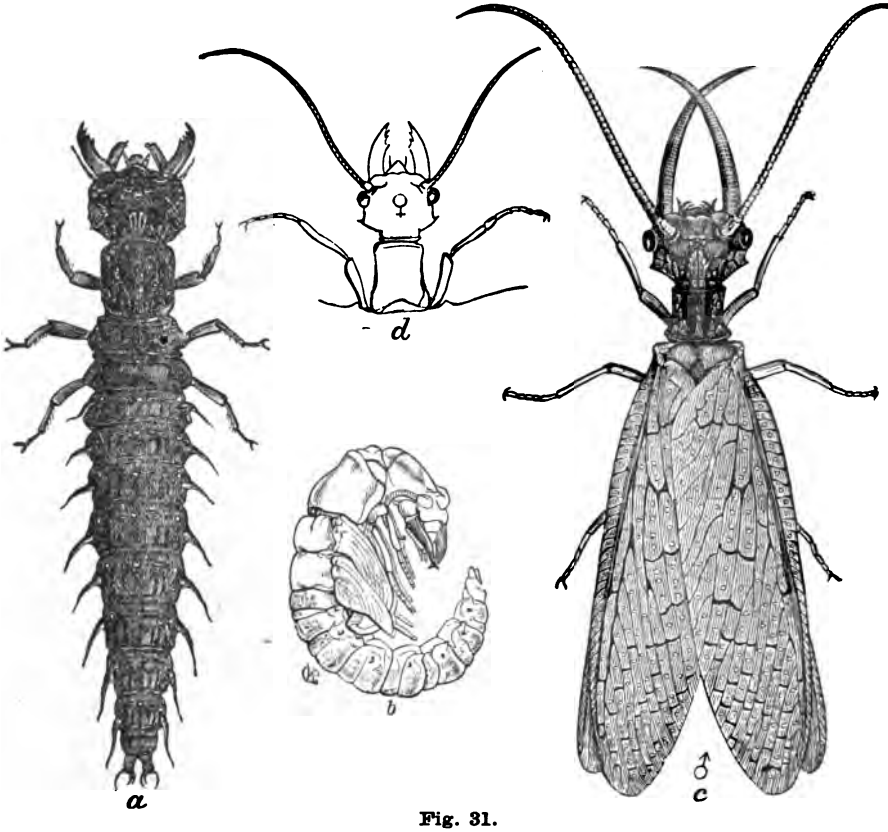

Fig. 31.

The hellgrammite, *Corydalus cornutus: a*, larva; *b*, pupa; *c*, male fly; *d*, head and jaws of female. (After Riley.)

is drawn out to a slender thread by lifting the abdomen, and then an egg is placed on the summit of this thread. The thread dries at once and firmly holds the egg in midair. When the young aphislion hatches, it crawls down the thread that holds up the egg and starts in quest of some insect which it can feed upon. The larvæ are spindle-shaped, and while they feed chiefly on plant lice, they

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will eat also such other insects as they can overcome, particularly soft creatures, like the larva of the elm-leaf beetle. The cocoon in which the pupa state is passed is a perfect sphere, generally white in

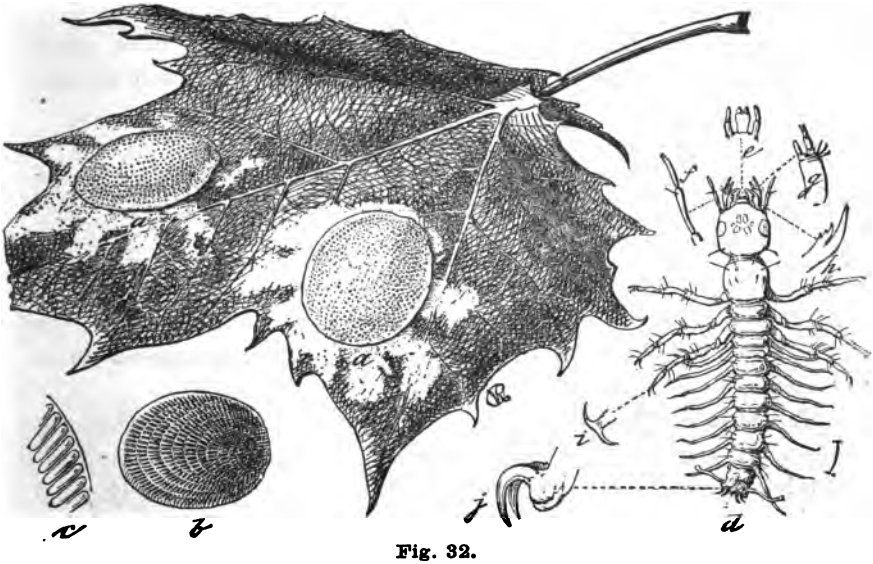

Fig. 32.

The hellgrammite: *a*, egg mass; *b*, same detached, from under side; *c*, single eggs; *d*, newly-hatched larva; *e* to *j*, details of larval structure. (After Riley.)

color, composed of dense layers of silk, and in order to emerge, the insect cuts a circular lid from one side. The adult, after it has emerged, does no feeding, and in that stage is found neither injurious

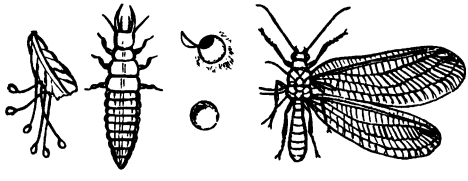

Fig. 33.

Chrysopa sp., lace-wing fly: *a*, eggs; *b*, larva; *c*, cocoon intact and after escape of *d*, adult. (After Riley.)

nor beneficial. Nor, indeed, is the larva one of nature's great checks on plant-lice increase, for it seems to prefer to spend its time on fences, or trees, or tree-trunks, and in similar situations, where it

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picks up indiscriminately those insects that come into its way, and it is not usually seen in our cultivated fields. Yet, it is well to recognize the fact that we have here an insect that is at least a check to many forms of plant lice feeding on trees, and does good work often by feeding on soft-bodied slugs or grubs, like the larva of the elm-leaf beetle, which has been already mentioned. We have many species of these "lace-winged flies," but they are all closely related,

Fig. 34.

Lace-wing fly from side, and eggs.

look very much alike and have very much the same life history. We need not, therefore, go into further details, but recommend these creatures to the distinguished consideration of farmers.

Allied to the preceding family, we have the "ant-lions," which, in the adult stage, are larger insects, with much longer and comparatively yet narrower wings, and generally dark or gray, rarely green or brown colors. These insects have no unpleasant odor when being handled; but some of them have a habit of curling up the abdomen, which gives the idea that they have the power of stinging, although

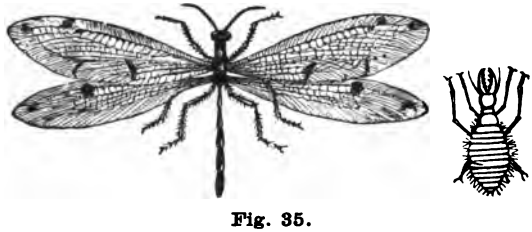

Fig. 35.

Myrmeleon, ant-lion: larva and adult.

such is not really the case. The larva resembles, in its general appearance, that of the aphis-lion, but is rather broader and more robust and has still larger jaws. It has the curious habit of building pitfalls in sandy places, at the bottom of which it lies in wait, almost covered by sand, and watches for some unwary insect, generally an ant, to tumble into its pit. As soon as this happens, the insect seizes it by means of its formidable jaws and its life's blood is sucked in a

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few moments. In case the insect does not tumble to the bottom of the pit at first and makes an effort to escape, our ant-lion quickly loads upon the top of its head a quantity of sand, and throws it with certain aim upon the struggling specimen, generally with the effect of

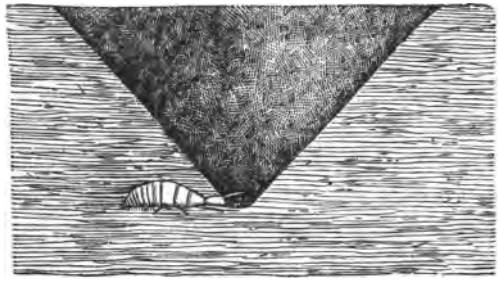

Fig. 36.
Section of pit of ant-lion. (From Standard Nat. Hist.)

bringing it within reach of its jaws. When it is full grown it forms a silken cocoon, very much as in the preceding series, but covered with grains of sand, which render it practically invisible in its surroundings. It is an interesting fact that this spinning is done from the anus instead of from the mouth, as is usual with insects. From this, in due time, issues the perfect fly, which is as harmless as its

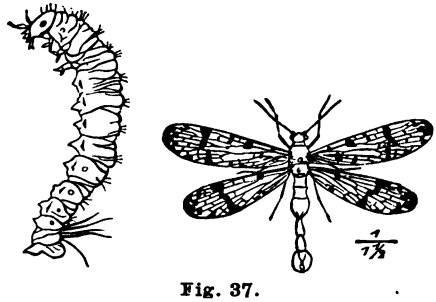

Fig. 37.
Panorpa, or scorpion-fly, and larva. (From Packard)

larva was rapacious. As a matter of actual fact, these insects can scarcely be called beneficial, because the insects upon which they feed are not really injurious, and because their number is, comparatively speaking, so small as to have no perceptible effect in decreasing the number of its prey.

The scorpion-flies, or *Panorpidæ*, are remarkable creatures, which obtain their name from the peculiar anal appendage of the male,

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which in a way resembles the tail of the scorpion and is curled up in a somewhat similar fashion. The mouth is prolonged into a very curious beak-like structure, and is entirely unlike that of any other family related to it. The larvæ somewhat resemble caterpillars, but live in the earth, making mines in every direction, or they may occur in moss on tree-trunks, and upon stones, and they probably feed upon insects found in such localities. They are predaceous insects and therefore to be classed among such as are beneficial, although practically they are of no value to the agriculturist, since the insects they feed upon are not injurious species.

Very curious insects are the "caddice-flies," so called principally from the habit that the larvæ have of building cases in running water.

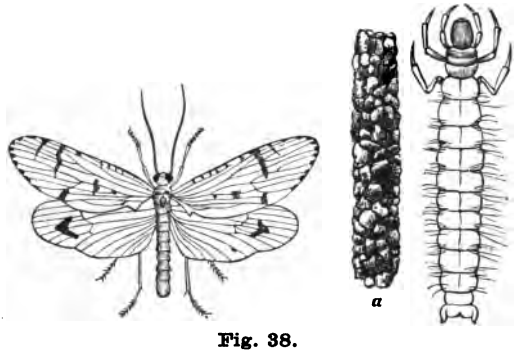

Fig. 38.

A caddice-fly, *Limnophilus rhombicus*. (From Standard Nat. Hist.)

These cases are usually tube-like, and are formed of sticks, stones, leaves, or, in fact, anything in the way of rubbish that the specimens can get hold of; but each species builds a characteristic case, and those that use stones never use sticks, so that in many cases it is easy to recognize the species from the case alone. These insects sometimes occur quite abundantly in ditches and streams that flow through cranberry bogs, where there is a sufficient stream of water to enable the insects to flourish, and as they sometimes use cranberry leaves in building their habitations, they have been supposed to be injurious to this plant. As a matter of fact, however, the leaves that are used are such as have fallen into the stream and have not been torn from the plants by the insect. The larvæ, so far from feeding upon vegetation, feed upon all sorts of insects and other animal matter that they are able to find in the water, and while they are not beneficial in

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the strict sense of the word, they are never in the least injurious. The adults are often found in numbers along the banks of streams and are quite readily attracted to light. They have the wings usually dark or dusky, sometimes colored and very frequently covered with hair or scales, resembling some of the lower moths, and when at rest they hold the wings in very much the same manner. The mouth parts are not well developed and they do not feed in this stage. Taken as a whole, we may say that in the order *Neuroptera* the great majority of the species are innoxious; that is, except in the aphis-

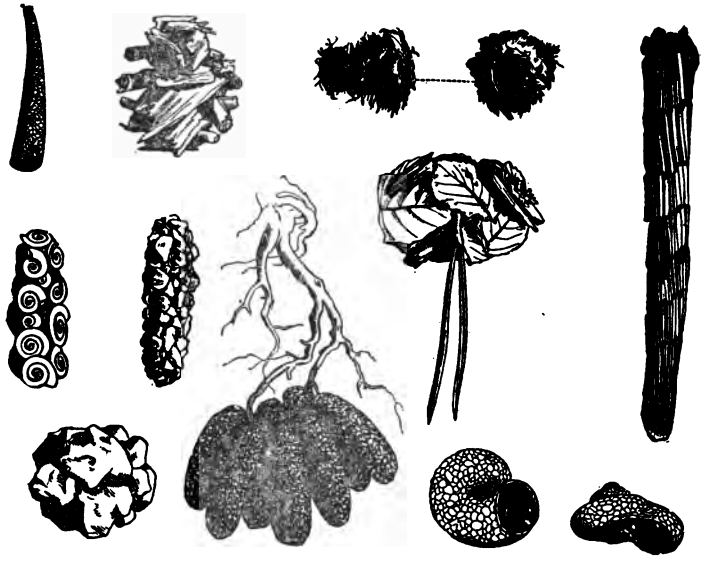

Fig. 39.

Caddice-fly cases. (From Standard Nat. Hist.)

lions, neither strictly beneficial, nor, except in the case of the parasites, at all injurious.

The order *Orthoptera* contains insects all of which, so far as our own State is concerned, may be reckoned as injurious. Some of them do little real injury, feeding upon plants that have no special interest or value to the farmer, but none that occur with us are beneficial. The only exception to the generally-herbivorous character of the order is in the case of the *Mantidæ*, also called "soothsayers," from the peculiar habit they have of holding their fore legs as if in the attitude of prayer. These are predaceous and feed upon whatever

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insects are foolish enough to venture within their reach, but they do not occur in our State except as rarities in the southern counties. Other members of this order are the cockroaches, crickets, grasshoppers, locusts, katydids and the like, and these are treated at some length in Bulletin No. 90 of the College Station, and in the Annual Report for 1892.

Cockroaches are almost omnivorous, and are said to devour other insects when pressed for food; they have also been credited with eating bed-bugs on occasion. So, crickets sometimes eat other insects and occasionally each other; the tree-crickets, especially, or some of

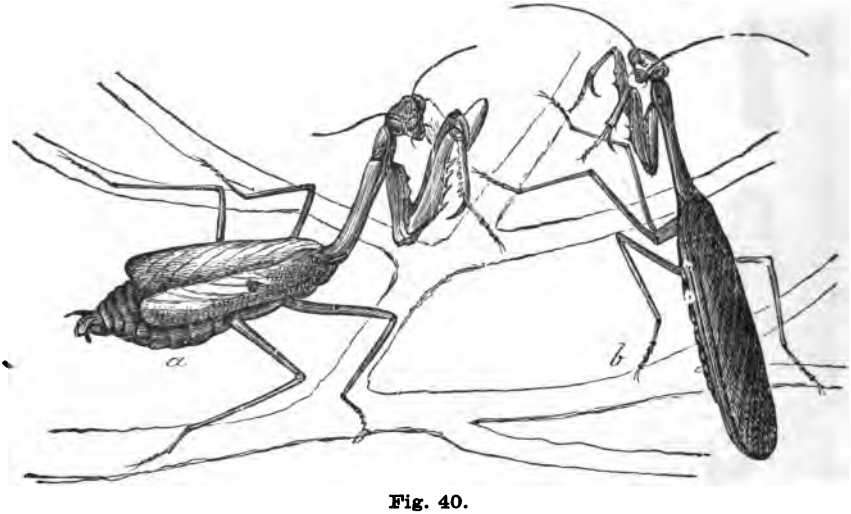

Fig. 40.

Stagmomantis carolina: a, female; *b*, male. (After Riley.)

them, being said to be quite fond of varying their usual vegetable diet. Yet, none of these could be properly called beneficial, and all the members of this order, as they occur in this State, may be considered as enemies to agriculture.

The order *Hemiptera* contains insects that obtain their food through a jointed beak, in which run pointed lancets, which can be used for piercing the material upon which they feed, and by this mouth-structure the insects belonging to the order *Hemiptera* can always be recognized. They are what the entomologist calls "true bugs," and, as a whole, the members of this order are injurious. They contain such insects as the "scale lice," "bark lice," "plant lice," "thrips,"

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"chinch-bugs," "bed-bugs" and the like. They have four wings, and on their character the order is divided into two main sections, in the first of which both pairs of wings are transparent or, at least, similar in texture, while in the other, the fore wings are partly thickened and of a leathery or even horny texture toward the base, while the tip is membraneous. In the first series, which are also called *Homoptera*, there are none that can be, in any sense of the word, called beneficial, and therefore all insects of this character which obtain their food through a jointed beak may be called injurious. Yet, even this series contains some insects that are of some importance, economically, other than as pests; for we have belonging here the cochineal insect, from which a most beautiful dye is secured; the lac insect, from which scale-lac is obtained, and the wax insect, from which, in China, a very useful wax is made. Yet, these are only apparent exceptions, for they are really destructive to the plants on which they feed; it happens merely that in these cases the insects are of more value to man than the plants. The case is somewhat different with the *Heteroptera*, as the second section of this order is termed, and many of these are predaceous, feeding upon other insects. It is somewhat difficult in all cases to say which of the members of this order are predaceous and which feed upon plants. First, all those that live in the water are predaceous, but they can hardly be called beneficial, for they do not feed upon insects or forms that are injurious to growing crops. Of the land insects, some are very indifferent where they obtain their food-supply, and they will spear a larva or puncture a leaf, just as they happen to feel or as opportunity serves. These can scarcely be called beneficial, even though they may not be

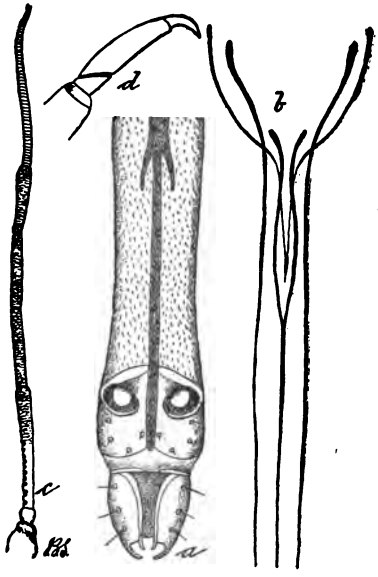

Fig. 41.

a, beak of wheat louse; *b*, the lancets contained in it; *c*, antenna, showing the sensory pits; *d*, tarsus. (Original.)

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actively injurious. There is, however, one group of the *Heteroptera*, largely belonging to the family *Reduviidæ*, which is entirely predaceous, and they can generally be recognized by the very small head, which is yet very distinct, and the small, though prominent eyes, set upon the sides. They also have the beak short and stout, only a very little curved and apparently arising from the front of the head. The largest of our species belonging to this series is known as the "wheel-

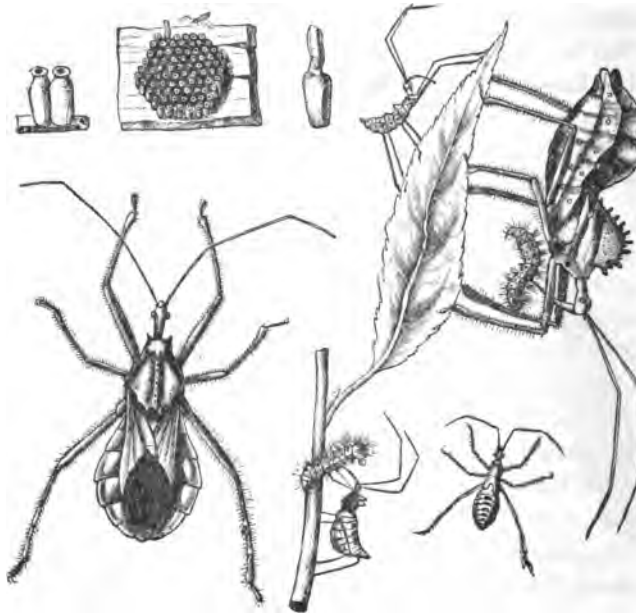

Fig. 42.

Prionidus cristatus, the "wheel-bug:" eggs, larvæ and full-grown specimens. (After Glover.)

bug," and is more common in the southern portion of the State. It gives a very good general idea of the appearance of the predaceous forms, although there is a considerable range of variation in size and color. All of the bugs with the head structure shown in the outline Figure 43 may be counted as beneficial or, at least, not actively injurious. All others of the *Heteroptera* should be looked upon with suspicion, although there are some forms belonging to the series in which the body is short and broad, with the head and thorax forming a triangle, largely belonging to the family *Pentatomidæ*, which feed occasionally, or even as a rule, upon other insects. Of this character

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is the *Podisus spinosus*, or spined soldier-bug, a clay-yellowish species with minute black speckles, which, among others, feeds upon the larvæ of the Colorado potato-beetle, destroying no inconsiderable number, and it has allies that resemble it in appearance and have similar habits. Among these *Pentatomids*, there are few in our State that are actively injurious, and perhaps the good done by other members of the family may overbalance the ill suffered at their hands. We also find, quite usually, that where bugs are predaceous in their habits, the fore legs are either stout and strong or armed with claws, or spurs, or spines, enabling them to grasp their prey. The appearance of some such leg structures is shown in Figure 46. The metamorphosis in the *Hemiptera* is incomplete—that is to say, the larva and the imago resemble each other, except that the former is never winged and there is no quiescent pupal stage. The predaceous species are

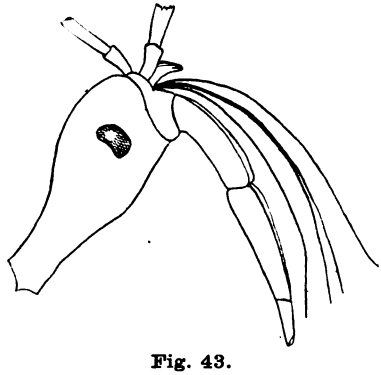

Fig. 43.

Outline of head and beak of predaceous *Hemiptera*. (Original.)

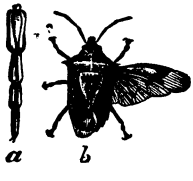

Fig. 44.

Podisus spinosus: a, enlarged beak; *b*, bug, with right wings expanded. (After Riley.)

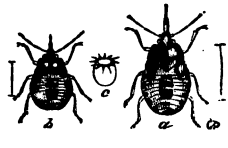

Fig. 45.

Podisus spinosus: a, pupa; *b*, larva; *c*, egg. (After Riley.)

useful, therefore, during their entire life, and they, undoubtedly, do considerable good. A quite notable feature in many of the *Heteroptera* is their odor, which is extremely unpleasant and quite characteristic. It is marked in the bed-bug, and is most marked, always, in the plant-feeding forms, though even the predaceous types are not free from it. In the well-known squash-bug, the odor is of a peculiarly sickening, musky character, which is less usual. Even the

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eggs have this peculiarity, as is sometimes unpleasantly manifest when one of them is chewed with a blackberry or raspberry. As a whole, it may be said that few of the insects belonging to this order are actively beneficial or of any advantage to the farmer.

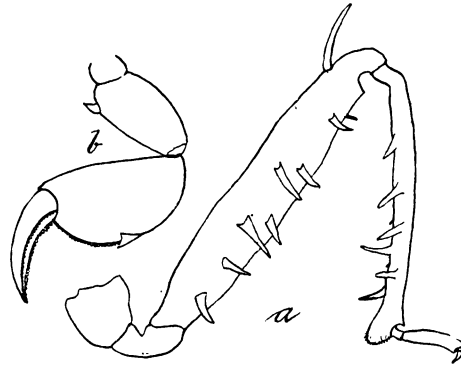

Fig. 46.

a, fore leg of *Reduvius; b*, fore leg of *Phymata*.

The order *Lepidoptera* includes the butterflies and moths. These insects are well known and it scarcely needs a description of the adults or perfect insects. They have four wings, usually of comparatively large size and densely clothed with scales of various forms which, when the insect is handled, rub off readily and appear on the fingers like dust. Under the microscope, however, it is seen that they have definite forms, some of them very beautiful, and that there are scarcely two species in which all the scales are exactly alike. The mouth is formed for sipping liquids and consists of a long, flexible tongue, which is coiled, when at rest, under the head. This tongue in some of the hawk moths, becomes enormously elongated, and in some of our species is from six to eight inches in length, able to reach to the bottom of the deepest flowers,

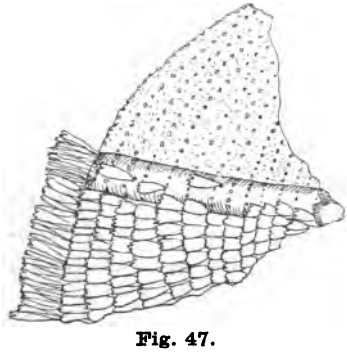

Fig. 47.

Fragment of butterfly-wing, partly denuded of scales, much enlarged. (Original.)

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to reach the nectar that is concealed there. In the moth state these insects are neither beneficial nor injurious, strictly speaking, although some of them are useful in so far as they aid in the cross-fertilization of flowers and fruits, carrying pollen from one blossom to the other: indeed some flowers are entirely dependent upon the moths that visit them for fertilization. To this extent only they are advantageous to the farmer. Their caterpillars are, in almost every case, injurious, and among the most destructive insects that we have are the larvæ of the *Lepidoptera*—"cutworms," "measure-worms," "webworms," "apple-worms," all belonging to this order. They can always be distinguished from the larvæ of all other insects by

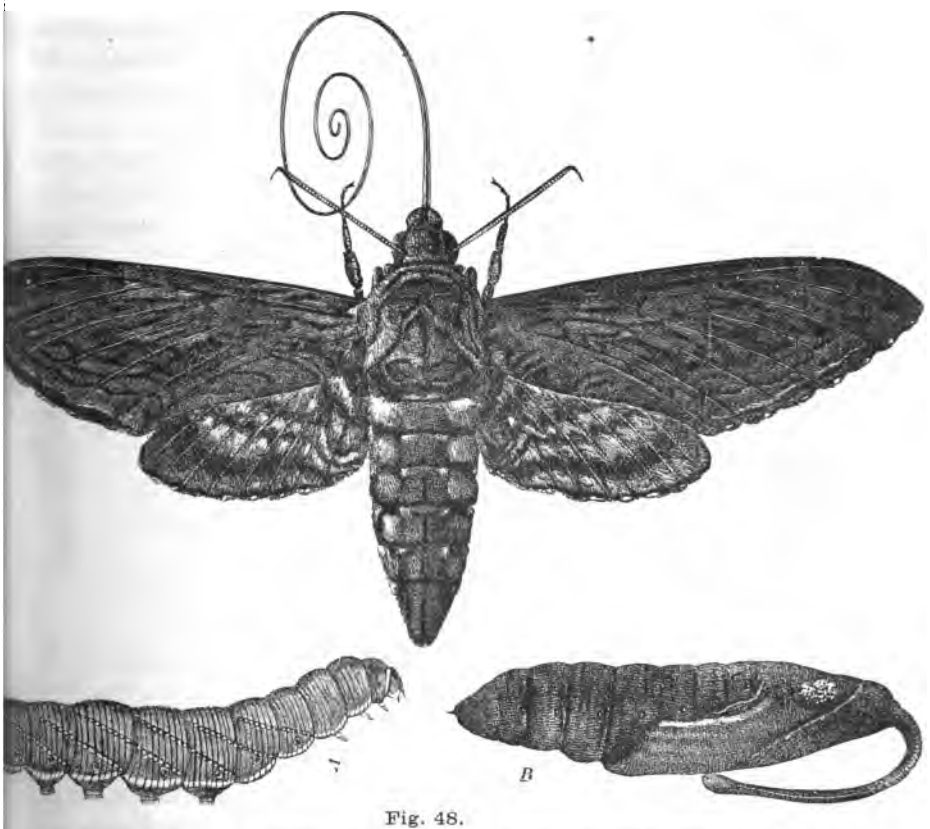

Fig. 48.

Potato-worm hawk-moth, *Protoparce celeus*: *a*, larva; *b*, pupa; *c*, moth, showing elongated tongue. (After Riley.)

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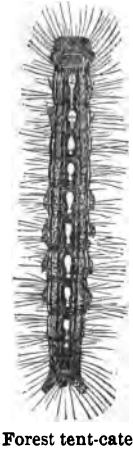
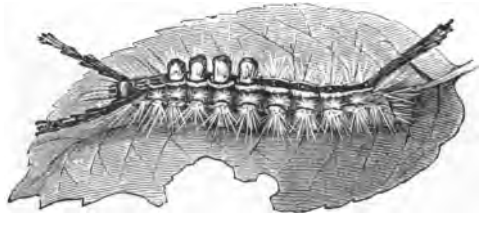
having, besides the three pairs of true legs, from one to four pairs of false legs in the middle of the body and another pair at the posterior end. Never do they have more than the number of legs above given, although they may have less, and eight pairs of legs always indicate the larva of a butterfly or moth. The larvæ of certain of the saw-flies resemble caterpillars very strongly and are sometimes known as "false caterpillars," but they have one additional pair of pro legs which renders them in all cases easily distinguishable. There are few rules without their exceptions, and we do even find certain exceptions to the general herbivorous character of the caterpillars. The larva of *Fenesica tarquinius*, one of our butterflies, feeds among the colonies of a certain woolly plant louse, while the caterpillar of one of the snout moths, or *Pyralids*, feeds upon bark lice. Among exotic forms there are several others that have a carnivorous habit, but neither of the species that occur in our State are of any practical

Fig. 49.

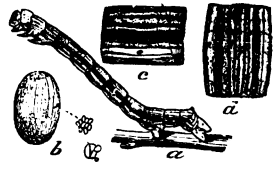
CATERPILLARS.



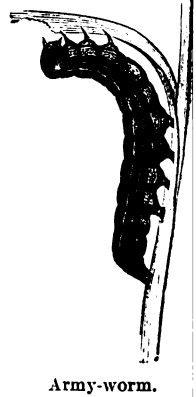
Forest tent-caterpillar.



Vaporer-moth larva.



Canker-worm.



Army-worm.

(All from Riley.)

importance to the farmer. They do not feed upon species that injure his field crops, and in any case they are found with us so rarely as to require close search to find them. So far as New Jersey is concerned we can take it for granted that none of the *Lepidoptera*, either in

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their larval or adult stage, are beneficial, and at the best they are only innoxious. Caterpillars may therefore be safely destroyed at any time.

The order *Diptera* includes the two-winged flies, and here we have an order in which we find insects that are directly beneficial and that are directly injurious, though, as usual, the majority are indifferent. It is not easy to distinguish one from the other, and indeed, within the limits of the same family, we may have species that are beneficial and species that are injurious. The members of this order can be distinguished in their adult stage by the presence of but two wings, which are absent only in certain degraded parasitic forms. The "sheep-tick," for instance, is a fly that has lost its wings on account of its parasitic mode of life, although many forms that are closely related to it, and are parasitic upon birds, have the wings well developed. The most degraded form is the "bee louse," which has lost all its resemblance to the order to which it belongs, and is blind as well as wingless.

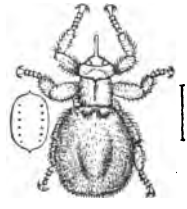

Fig. 50.
Sheep-tick, *Melophagus ovinus*.

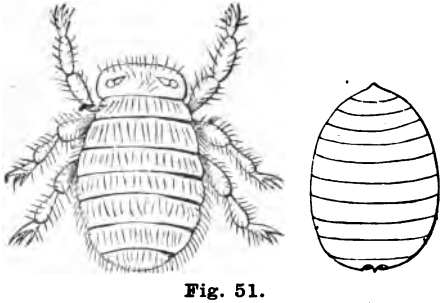

Fig. 51.
Bee louse, *Braula cæca*: *a*, its larva; *b*, adult. Greatly enlarged.

No fly has more than two wings, and this character always serves to distinguish the order *Diptera*, which means "two-winged." The fleas are usually classified as belonging here, although they have no wings at all in any species. There is considerable ignorance concerning the life history of the fleas, and though they can scarcely be termed beneficial, a few words on the subject may be excused. The adults, as is well known, infest warm-blooded animals, subsisting upon their blood. When the females are impregnated and ready to

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lay eggs, they leave their host, usually while it is at rest in its den or lair, or lying down in a suitable place, and the eggs are dropped loosely to the ground. From these eggs hatch little, white, worm-like larvæ, with black heads, which feed on damp vegetable matter

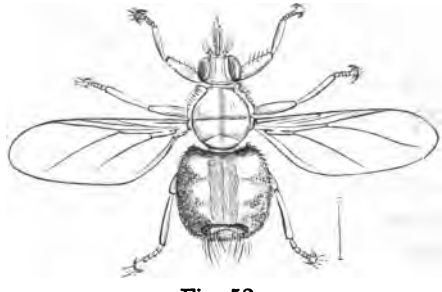

Fig. 52.

"Bird-tick," *Olfersia*, sp.

or rubbish of all kinds. A heap of sawdust or shavings is an ideal spot, and in the spaces between the boards of flooring there is always an accumulation of dirt that suffices to feed them. When the larvæ

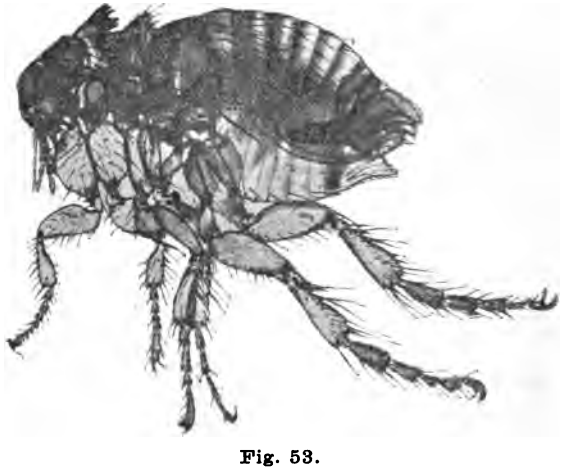

Fig. 53.

Rabbit-flea, *Pulex cuniculi* (?), greatly enlarged. (From a photograph.)

are full grown, they change to the adult or flea state, and then hop about until some suitable animal comes within their reach. Among the flies, we find very extraordinary developments of mouth

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structures. They are sometimes made into formidable weapons like those of the horse-flies, and of the mosquitoes, and are sometimes formed like those of the ordinary house-fly, simply for lapping. In no cases are they formed so that the fly can eat solid food; it must always be taken in the form of a liquid. When a fly attacks a lump of sugar, therefore, it first moistens it with a drop of its own saliva, and the sugar, so far as it is dissolved by this drop, is pumped into the stomach of the fly. Flies are, in consequence, most readily attracted to liquids and to material that is decaying or undergoing fermentation, where the solids are breaking up. There is a very great difference in the larvæ in this order; but, perhaps, the larger proportion of them will come under the head of "maggots." Many of these maggots have a very distinctly beneficial influence, for if they do not actually destroy other insects which injure the farmer, yet they assist in removing dead material, both of vegetable and animal origin, and in changing its form so as to enable it to return to the soil from whence it came and to be assimilated again by plants. It has been said that flies could devour an ox quicker than could a lion, and though this is somewhat exaggerated, still, under some circumstances, it is surprising how rapidly even a large carcass is made away with by these insects.

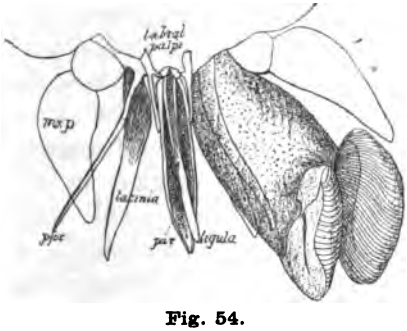

Fig. 54.

Mouth parts of *Tabanus* or horse-fly. (Original.)

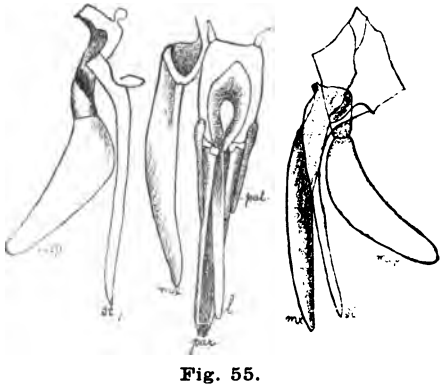

Fig. 55.

Mouth parts of horse-fly, showing lancets dissected out. (Original.)

In the great group of midges or *Cecidomyidæ* we count many most troublesome forms. We have the "cranberry midge;" the "pear

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midge," which is treated in a previous part of this report; the "wheat midge," the "Hessian fly," the "clover-seed midge" and many others which are certainly in no sense of the word anything but most injurious. We also have certain species that feed in the galls of phylloxera, and others that feed on forms of plant lice or even other insects, but these are rather exceptions and do little real good to the farmer. We may say, generally, that the midges are injurious rather than beneficial, and midge larvæ, or midges themselves where they are observed, should be looked upon with suspicion, and especially where they are observed in plant tissue or on fruits. The midges resemble, generally, a mosquito, and some of them are exceedingly small. The figures that are given herewith illustrate the usual form of midges and of their larvæ. The latter are generally long, oval, slightly flattened, that is to say, hardly cylindrical, a little pointed, as a rule, toward the head, and generally furnished with a curious little brown hook, which is called the breast bone, but is really a part of the mouth structure and serves the insect for scraping the tissue of the plant in which it feeds.

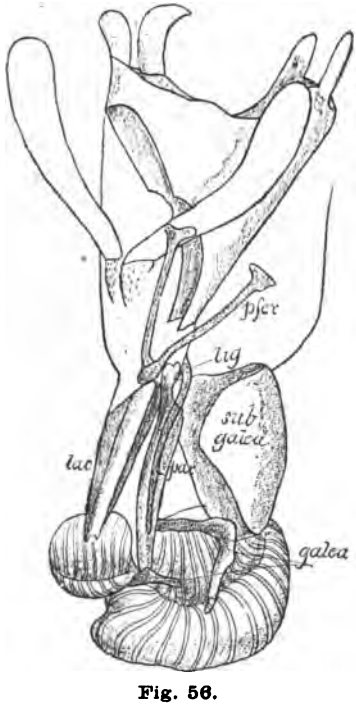

Fig. 56.
Mouth of blow-fly. (Original)

Somewhat allied to the midges in appearance are the fungus gnats, belonging to the family *Mycetophilidæ*. Of these we have many species, feeding not always upon fungus, but sometimes upon exudations from trees, or even in decayed woody matter. The larvæ of one genus at least, *Sciara*, have been long known for their gregarious habits. When about to change to pupæ, they assemble in immense numbers, forming processions that have been observed four or five inches wide and ten or twelve feet long. They travel in a solid column from four to six deep, over each other, advancing about an

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inch a minute. From this peculiar habit, they have been called the "army-worm" in Europe, but are, of course, quite a different insect from that which has been honored with the same name in this country. These larvæ are long and slender and have a black head in most instances. None of them can be considered as beneficial, and in some few cases they actually become injurious, as, for instance, when mushrooms are raised for market.

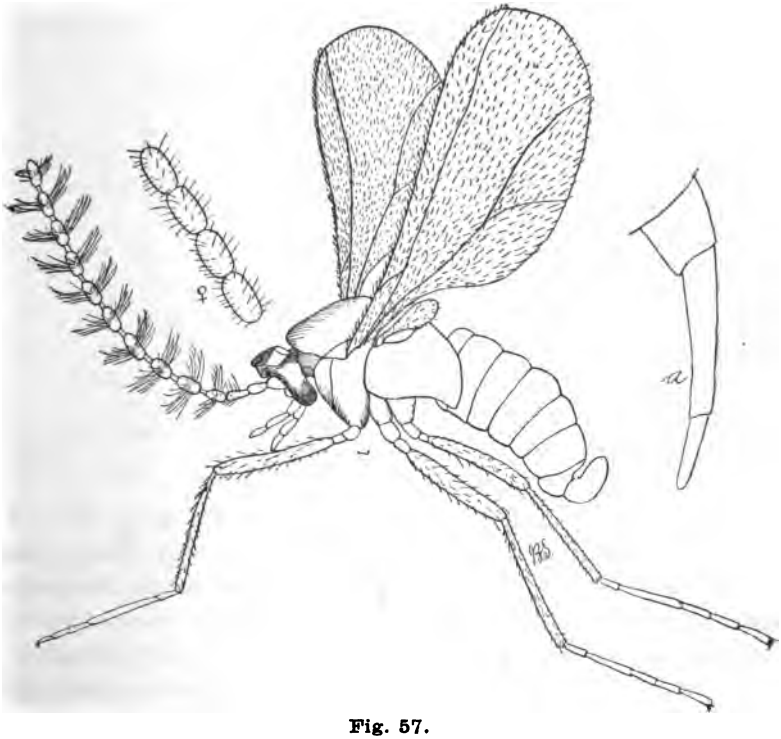

Fig. 57.

Cranberry midge: *a*, ovipositor of the female, enlarged. (Original.)

Passing over a number of families, including the "black flies" and several forms allied to the true mosquitoes, and the mosquitoes themselves, which are scarcely to be reckoned among the beneficial insects, we come to the *Tipulidæ* or "crane flies," or "daddy long-legs," which also have a mosquito-like form, although usually many times larger. The mouth parts are not formed for piercing, and the enormously-developed, slender legs are quite characteristics. The larvæ are long and slender; most of them live

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underground, on woody material, including therein the roots of quite a number of plants, and they are often known as "wire-worms," and correspondingly injurious. They are mentioned here only as the last family of the series of flies that have long antennæ or feelers. In a general way, and for all the purposes of this paper, we can say that none of the two-winged flies that have long feelers or antennæ can be looked upon as really beneficial insects in any stage;

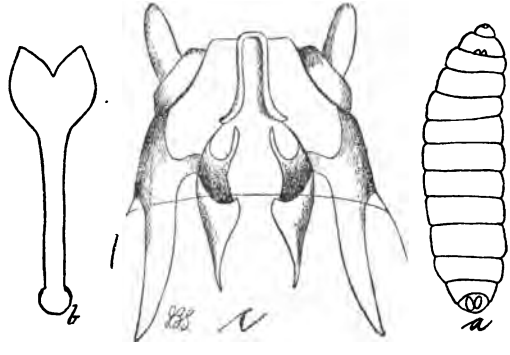

Fig. 58.

Cranberry midge: *a*, larva; *b*, breast bone of same; *c*, mouth parts. Greatly enlarged. (Original.)

for although, as I have already stated, some of the midge larvæ are predaceous in their habits, and others live in the water, doing at least no active damage, yet a very large number indeed of the species that have an interest to the agriculturist are active feeders upon vegetation, and in some cases upon our most important crops. The discussion of these does not belong to this article, and it will suffice to repeat again that flies, large or small, with long and many-jointed feelers, are to be looked upon as enemies rather than friends—to be destroyed rather than fostered, as opportunity serves.

The remainder of the flies have the antennæ short, and as a rule not more than three-jointed, although sometimes the last joint may be ringed in such a way as to give the impression of a number of segments. We have first in this series the forms which are and which resemble the horse-flies—large species, or at least of moderate size in most instances, with a vile habit of attacking animals and man, puncturing the skin and sucking blood. The mouth parts are formed of quite an elaborate set of lancets or piercing organs, as shown in Fig-

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ures 54 and 55, by means of which the flies can, almost in an instant, puncture the thickest skin and draw blood. They are certainly not to be considered as beneficial insects in any sense of the word. Their larva do have some economic value and are carnivorous as a rule. Many live in the earth, others in the water. They are predaceous upon snails and injurious insects, thus in a measure repaying the agricul-

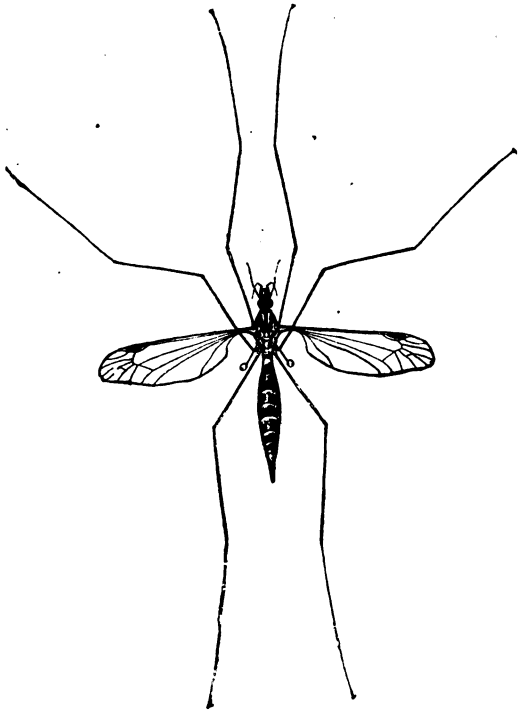

Fig. 59.

Crane-fly, *Pachyrrhina*, sp. (?) (After Webster.)

turist for the molestation they have caused him. The young larvæ are known to penetrate those of beetles and of other orders, and remain within them until they have completely consumed them, and we find thus an approach to a parasitic habit. Unfortunately the tendency of these larvæ is not to live in cultivated fields, but rather in woods or in low meadows, and hence, although the larvæ may destroy a great number of plant-feeding insects, yet they do not trouble those pests that are of serious importance to the farmer.

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Horse-flies and their allies can therefore be considered as more troublesome than beneficial on the whole, and need not be favored at any time.

The family *Asilidæ* contains the "robber-flies." They are mostly large, some of them very large indeed, one species measuring two

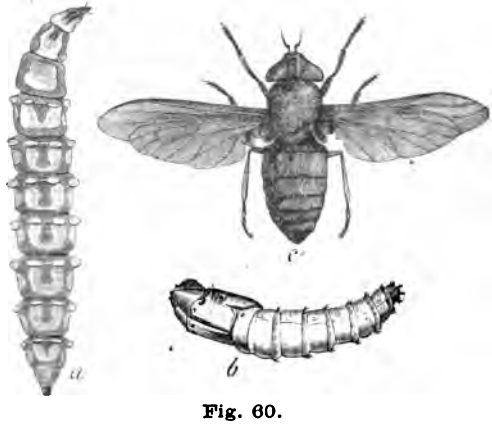

Fig. 60.

Tabanus atratus, black horse-fly : *a*, larva ; *b*, pupa ; *c*, imago. (After Riley.)

inches in length. The wings are narrow, the abdomen is very long and spindle-shaped, the head is large, with a powerful, piercing mouth, and the legs are stout and set with spines. They are the most predaceous of all flies, and indeed one might say of all insects. A great part of them rest upon the ground and fly up, when disturbed, with a quick, buzzing sound, only to alight again a short distance ahead. All their food, which consists wholly of other insects, is caught upon the wing. Their luckless victims when once seized by their stout, strong legs are powerless to escape. They are not particular in their choice, and any insect flying by them is at once pounced upon as by a hawk. I have frequently observed them carrying off grasshoppers, and in several instances have seen even quite large beetles attacked, the beak

Fig. 61.

The bee-killer, *Asilus missouriensis*. (After Riley.)

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being inserted between the thorax and elytra or wing covers. These might be considered as distinctly beneficial forms were it not that they have an unfortunate habit of attacking bees as well as other insects, and one species has been recorded as having destroyed as many as one hundred and forty-one honey bees in a single day. Their habit, too, of attacking only flying insects reduces their usefulness to a considerable extent, and the more so as they rather favor large forms, while among our injurious species perhaps the majority are small and in themselves insignificant. So indiscriminate are these creatures in their destructive tendencies that they do not even spare their mates, and unless the male is very careful the female, in return for favors received, will spear him and kill him. The larvæ are cylindrical, or somewhat flattened, with a parchment-like skin, without legs or with only abdominal protuberances. They live chiefly underground or in rotten wood, especially in places infested with grubs of beetles upon which they feed. The young may burrow their way completely within beetle larvæ and remain until they have consumed them. Many are found, however, where they evidently feed upon rootlets or other vegetable substances. They undergo their transformations in the ground, the pupæ have the head provided with tubercles, and on the abdominal segments there are also spiny protuberances and transverse rows of bristles, which aid the insects to reach the surface when they are ready to escape as flies. "Robber-flies," therefore, are to be encouraged, since none of them in the larval state are actively injurious, while many are distinctly beneficial and, except so far as the bee-keeper is concerned, the adult flies themselves may be considered as being decidedly beneficial in the true sense of the word.

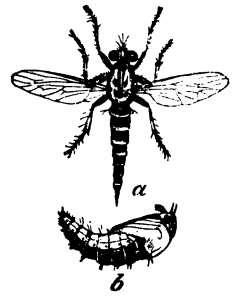

Fig. 62.

The bastard robber-fly, *Erax bastardi*: *a*, fly; *b*, its pupa. (After Riley.)

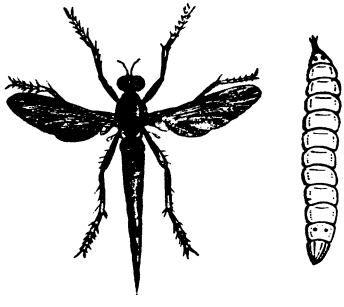

Fig. 63.

Silky robber-fly, *Asilus sericeus*, and its larva. (After Riley.)

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Next follows a little series of insects to which the name "bee-flies" has been applied, from the resemblance which many of them bear in appearance to bumble-bees, although their habits of flight are quite different. They may be seen hovering over flowers, poising them-

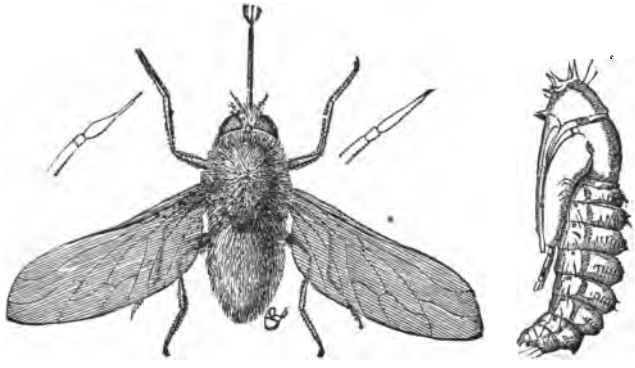

Fig. 64.

Systœchus oreas: bee-fly parasite on grasshopper eggs; fly and pupa. (After Riley.)

selves like humming-birds and darting off as rapidly if disturbed. Frequently they are found on sandy roads or patches, sometimes alighting, but always ready to take flight. A few forms are more sluggish, with shorter tongues, and these are often found on flowers, walking over them quite deliberately. Two families are represented,

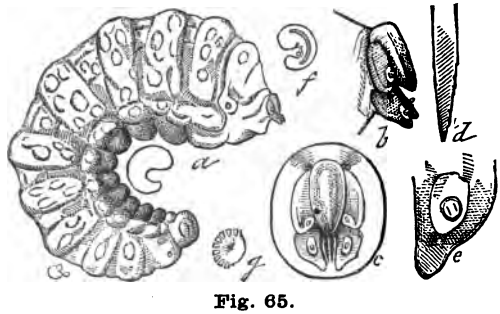

Fig. 65.

Larva and details of structure of bee-fly, *Systœchus oreas.* (After Riley.)

which need not be distinguished for our purpose. They are generally heavy-bodied insects, black and yellow in color, very frequently with a golden appearance, though sometimes with a fine silvery white

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luster, and they are remarkable in some instances for their greatly-extended mouth parts. One species from Africa particularly, which although only about two-thirds of an inch in length, has a proboscis nearly three inches long, enabling it to suck the nectar from long-tubed flowers like *Gladiolus* and its allies. Not all of the bee-flies have the tongue so greatly lengthened, but all of them have very much the same food habits, and in all of them the mouth parts are so constructed that they cannot use them to pierce, but are confined to liquid food. They are thus neither beneficial nor injurious to the agriculturist, but the larvæ belong decidedly to the category of beneficial insects. So far as we know about them they are predaceous or actually parasitic. In some cases the eggs are laid within the channels of wood-boring insects, although the larvæ may not in each case feed upon the makers of the borings.

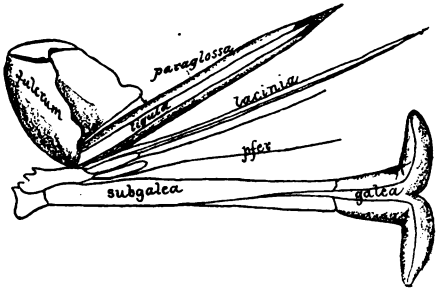

Fig. 66.

Mouth parts of long-tongued bee-fly. (Original.)

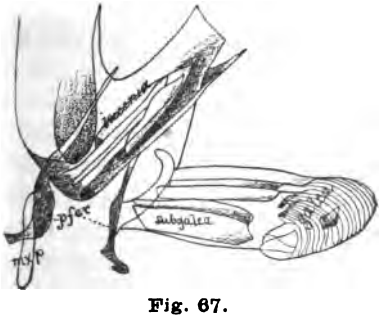

Fig. 67.

Mouth parts of short-tongued bee-fly. (Original.)

In the true bee-flies, *Bombyliidæ*, the larvæ are parasitic and predaceous, and among the most useful of these are certain forms like the *Systœchus*, above figured, that feed upon the egg-pods of grasshoppers. Some of them are also parasitic in the nests of bees, and probably of other insects, and some genera are quite usually parasites on caterpillars. We know the life history of only a comparatively few forms belonging to this order, but so far as we do know, they are insects to be well considered, and are directly beneficial in the sense that they lessen or keep in check some of the forms that are really injurious to the farmer. The bee-flies, therefore, should not be disturbed, and their abundance should be considered an advantage worthy of notice.

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There follow in the natural classification a number of families, some of them containing a very large number of species, and of quite diverse forms, though perhaps the most numerous are those having a certain resemblance in appearance to the "robber-flies," and belonging to the family *Empidæ*, which have also much the same predaceous habits, feeding upon other insects, but principally flies of all kinds. The larvæ in these families are generally slender and elongate, sometimes with and sometimes without distinct feet, and in most cases they live in the earth, where they feed, probably, upon other insect larvæ, and in some cases it is likely also upon decaying vegetable matter.

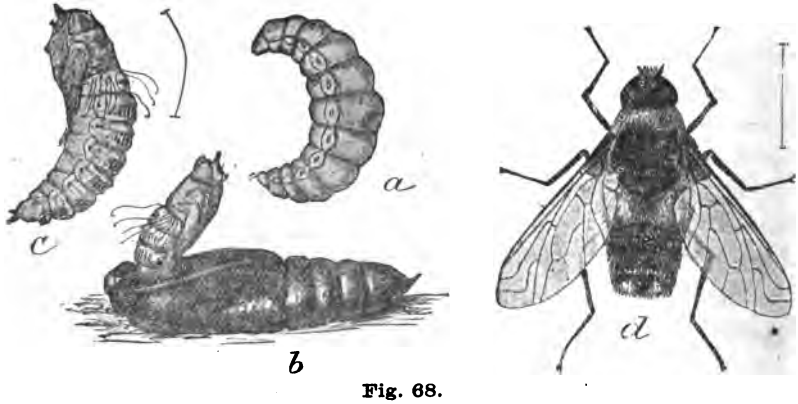

Fig. 68.

Anthrax hypomelas, bee-fly, parasitic on cutworms: *a*, larva; *b*, pupal skin protruding from cutworm chrysalis; *c*, pupa; *d*, fly. All enlarged. (From "Insect Life.")

They are, therefore, in a sense beneficial, although, as they prefer woodlands or brushlands, especially in the vicinity of brooks and streams, and are not commonly seen in cultivated fields, their actual importance to the farmer is not great. One species, belonging to the genus *Scenopinus*, lives in houses quite generally, and is smaller and less robust than the house-fly, and of a somewhat metallic hue. Its larva is a very long, slender creature, and is quite frequently found under carpets, where it is looked upon with suspicion by the careful housewife. As a matter of fact, however, the larvæ do not feed on woolens or upon anything treasured by the ladies, but rather upon those creatures that do injure carpets and the like, among others the so-called "buffalo moth" and the "carpet moth," although their principal food is probably the small paper lice, which are not unusually found in dwellings where the walls are papered. Some of

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the flies belonging to this series are very prettily colored, metallic blue and green, with delicate wings and unusually long legs, which in one family, called the *Dolichopodidæ*, are sometimes peculiarly clubbed and paddle-shaped in the male. All of these small, long-legged flies that are blue or green and metallic in color, may be looked upon as friends, or at least not as active enemies, since they do not in any case feed upon vegetable matter which is of interest to the farmer.

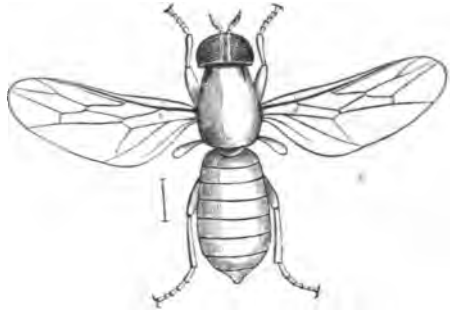

Fig. 69.

Scenopinus fenestralis. (From "Packard's Guide.")

Now follow the series of species in which the larvæ have the typical maggot-like form more or less distinctly marked. The head is never distinct, the first segment is never hard, and has soft, wart-like feelers, or it is even entirely without appendages, showing only a mouth opening. The body is cylindrical or somewhat flattened, smooth, or with swellings for locomotion, or with girdles of short bristles, sometimes with thread-like filaments. The larvæ shed their skins two or three times before assuming the pupal stage, escaping through a rent at the posterior end. The pupæ are always inclosed in the contracted larval skin, the adult insect escaping through a circular orifice at the anterior end.

The first family belonging to this series is the *Syrphidæ*, which is a very interesting one from any standpoint, and is one that is of considerable importance to the farmer. The larvæ differ quite considerably in appearance and fully as much in habit, while the flies resemble each other very much more, and are gayly colored, red and yellow banded, and frequently clothed with hair, sometimes so densely as to resemble bees. Others of these flies resemble wasps quite closely, and very frequently mislead the casual observer. One set of the larvæ of some of our larger species are parasites in the nests of bumble-bees; others feed in decaying and excrementitious matter. The latter are furnished with a curious

Fig. 70.

Rat-tailed larva of *Eristalis.* (From "Packard's Guide.")

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appendage resembling a tail, and they are called rat-tailed larvæ in consequence. This is, however, not a tail in any true sense of the word, but is rather an arrangement to enable the larva to breathe. It lives in the midst of its food, surrounded by it on all sides, and in such a medium there is no possible chance of getting air from the surroundings. The tail is therefore extended to its full length so as to reach above the foul masses and through the tip of this structure, which is really a flexible tube, air is obtained, and a communication with the outer world is established. The flies hatching from these larvæ resemble bees very strongly in appearance, and they make a loud buzzing sound in their flight. They very frequently enter rooms in the fall, and buzzing about and against the windows are quite usually mistaken for bees. These flies are not infrequent in greenhouses, and by some florists they are known as "chrysanthemum-flies." They appear at about the time that these flowers are in bloom, and are supposed to be the agents required to fertilize them. Exactly how much truth there may be in this is by no means determined as yet, but at all events the insects are certainly not injurious in any sense of the term. The forms, however, that are of the greatest interest to the agriculturist are those which in the larva state feed upon plant lice, and of these there are a very great number of species. Many of them belong to the genus *Syrphus*. They are usually not very large, rarely more than one-half an inch in length, quite as pretty as most others of the family, and are remarkable for their rapid motion in the air, and for the

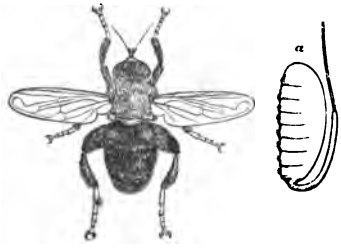

Fig. 71.

Mallota posticata: *a*, its pupa case. (From "Packard's Guide.")

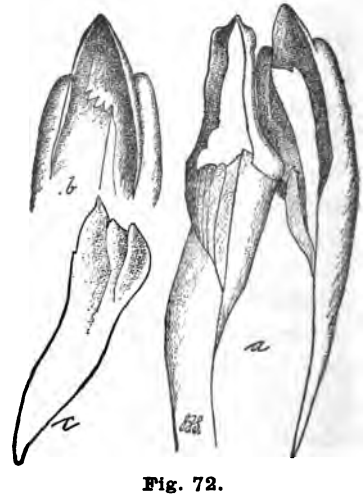

Fig. 72.

Syrphus torvus, mouth parts of larva: *a*, the complete mouth; *b*, the upper jaw; *c*, the mandibles. (Original.)

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way in which they hover over flowers. The larvæ are cylindrical maggots without a head, and the mouth parts are apparently formed of from two to four outwardly-bent hooklets. The eggs are deposited by the females upon plants that are infested by plant lice. The young larvæ as soon as hatched crawl over the stems and leaves until they come in contact with the lice, which they pierce with the hooklets, and holding them up, suck out their juices, to the number of a hundred or more daily. When ready to undergo their transformations they attach themselves to the leaves, and the larval skin contracting forms an oval puparium. These flies are of very decided importance and of the most direct benefit to the agriculturist, and they fortunately prefer the open fields and are therefore likely to appear just where they are most needed by the farmer. There is no more important agent in this State for checking such creatures as the wheat plant louse, and I have already called attention to the species that is most abundant in this good work in Bulletin 72 of the Station. The figures showing the fly, the larva, and its mouth structure are reproduced here in order that they may be recognized under all circumstances. When, a few years ago, the wheat lice became unusually abundant in this State, it was seen to be impossible to pick off an infested wheat head without finding one or two of these larvæ, and wherever a spray was so furnished the lice would disappear within a very short time thereafter. Rapidly as the aphids can increase they cannot increase so fast as to get ahead of these syrphus-fly larvæ. The only unfortunate feature in the whole matter is that only the second brood of these larvæ become abundant enough to do any real good, and by the time they are ready to master the lice, the lice have done a very large proportion of their injury, and the crop has been very considerably damaged; yet in many cases, while they do not prevent all damage, they have prevented total failure. A great many

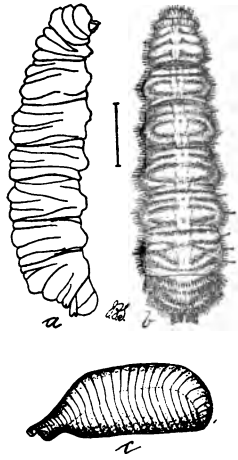

Fig. 73.

Syrphus torvus: *a*, larva, from side, showing the wrinkled appearance; *b*, same, from above; *c*, pupa. (Original.)

Fig. 74.

Syrphus larva holding up its prey. (After Riley.)

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other species that are more or less useful occur, and not all upon the leaves of plants only. One form, *Pipiza radicans*, lives underground, feeding upon the apple root-lice and the grape root-lice, or phylloxera. This family is one of the best friends of the agriculturist and should be known by every farmer, since it contains no species which does him any injury, though some larvæ are said to be pollen-feeders.

Fig. 75.

Syrphus torvus, mature fly. (Original.)

A family which is closely allied to the preceding is the *Conopidæ*, and these resemble quite frequently, in a most remarkable manner, certain species of wasps. They are pretty flies, and are also found upon flowers. The larvæ of the members of this family are parasitic, chiefly upon bumble-bees and wasps, which perhaps accounts in some measure for their resemblance to the latter insects, but they have also been found in the egg-pods of grasshoppers. Specimens of *Conops* have been noticed following a bumble-bee and repeatedly flying against

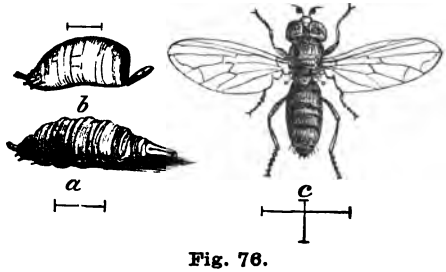

Fig. 76.

The root-louse syrphus-fly, *Pipiza radicans: a*, larva or maggot; *b*, puparia; *c*, fly. (After Riley)

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it. It is probable that the eggs are thus deposited by the female upon the body of the bee, and, hatching, they burrow in the abdominal cavity and there remain, feeding upon the soft tissues until they have arrived at the period for their transformation, when they escape in the adult form through an opening made between the abdominal rings. Though these insects are parasitic, it is perhaps a question whether they can always be considered beneficial, and they may even be claimed as injurious in some cases, because bumble-bees perform a very important function in the course of nature, the fertilization of some clovers depending upon them in very great part. At all events they cannot be praised as unreservedly as the members of the preceding family, except so far as they infest grasshoppers.

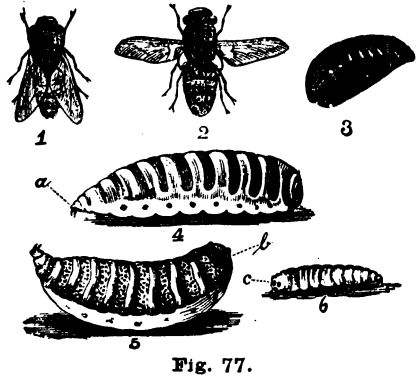

Fig. 77.

Sheep bot-fly, *Œstrus ovis*: *1*, *2*, adult fly; *3*, pupa; *4*, *5*, full-grown larvæ; *6*, young larva. (After Riley.)

In the natural system there follow the "bot-flies," or *Œstridæ*. These are assuredly not beneficial, living in animals of many descriptions, and, among others, infesting farm animals. They are, therefore, to be considered as injurious, and need no further reference here. In order that they may be recognized, a figure of the sheep bot-fly is inserted here.

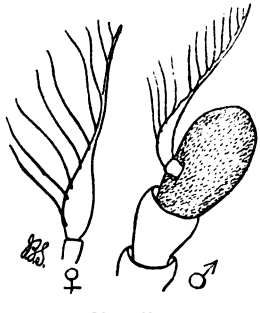

Fig. 78.

Antenna of fly, showing a feathered bristle. (Original.)

There follows now a very large series of flies that may be loosely termed *Muscidæ*, although they comprise really a considerable number of families. The common house-fly and the "blue bottle," or "blow-fly," at once recall the appearance of this family, which is of very great extent. The antennæ are three-jointed, the terminal joint being flattened and with a more or less plumose bristle. The proboscis ends in a fleshy lobe, like that of the blow-fly (Figure 56) in

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many instances, but in others the mouth parts are modified for piercing, as in the common cow-fly, or in the horn-fly, which so recently has been troublesome in our State. Perhaps the greater

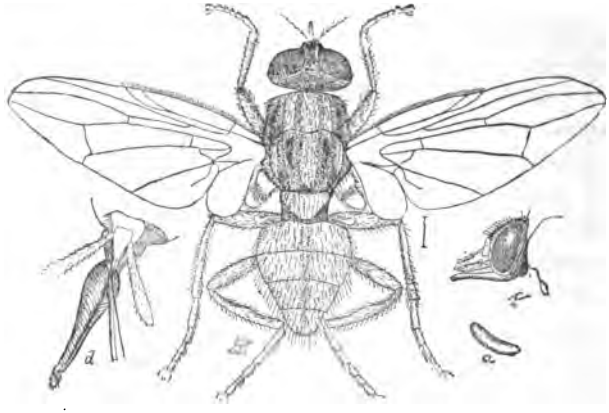

Fig. 79.

Horn-fly, *Hæmatobia serrata*: *a*, egg; *b*, fly; *c*, head from side; *d*, mouth parts. (Original.)

part of the insects belonging here are feeders upon decaying animal or vegetable matter, and are maggots *par excellence*. We have, however, in this series a mixture of injurious and beneficial insects, which it is difficult to separate so that they can be recognized by any but the special student. Perhaps this will be a good place to call attention to the fact that flies, after they have once become flies, never grow. There is no relation, direct or indirect, between the large flies that we see sometimes in early spring and the small flies that follow later. From the time that the adult makes its escape from the pupa to the end of its life, it remains of exactly the same size, and never varies one way or the other. I am induced to call attention to this point, because, perhaps, one of the easiest ways to describe flies is by size and general

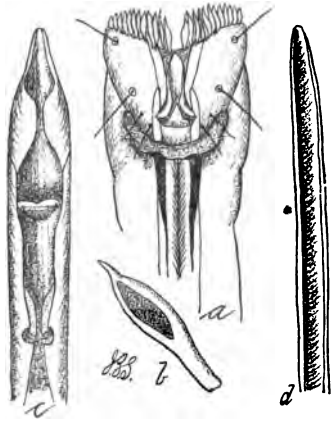

Fig. 80.

Mouth parts of horn-fly: *a*, tip of the sheath; *b*, one of the fleshy processes of same; *c*, lancet guide and piercer; *d*, lancet. Enlarged. (Original.)

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color. Large flies, of the size of the blow-fly, or a little smaller, if they are blue or green in color, are generally scavengers, and lay their eggs in decaying matter, vegetable and animal. In so far as they assist in removing such material, they are beneficial, but not in any direct sense from the farmer's standpoint. Some of them may be even classed as injurious, since they occasionally lay their eggs in living animals and even man, where an offensive discharge from the mouth or nose or from sores may attract them, and the maggots may, in some cases, cause a very great deal of trouble. Of such character is the "screw-worm," which, in the South and Southwest, has been a sad pest, but which, though it is common in our own State, has not been troublesome here. Small flies, smaller than the ordinary house-fly, more graceful and slender in general build, with pretty banded or smoky wings, may be generally

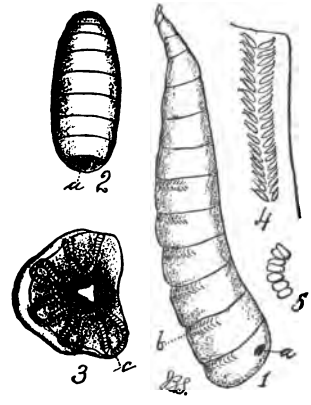

Fig. 81.

1, larva of horn-fly; *2*, pupa; *3*, anal stigmata; *4*, motile processes of larva. (Original.)

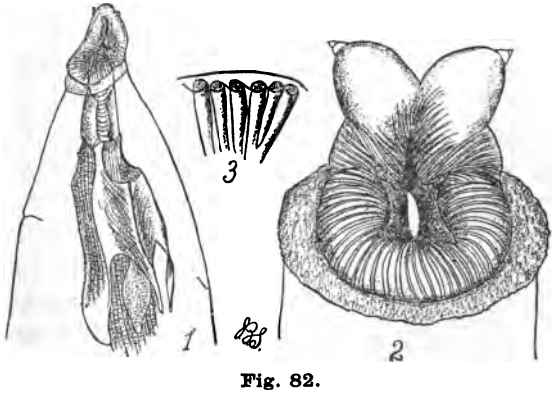

Fig. 82.

Horn-fly larva: *1*, head and sucking stomach; *2*, mouth parts, enlarged; *3*, ridges of same yet more magnified. (Original.)

looked upon as injurious. They comprise such forms as the "apple-maggot," the "onion-fly" and others of similar character. Some of the forms are called "peacock-flies" from the habit they have of

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strutting about and elevating their wings as a peacock does its tail. These insects live mainly in fruits or tubers, sometimes laying their eggs in the sound fruit and sometimes at points where it has been injured. The maggots then increase the injury and entirely ruin the specimen.

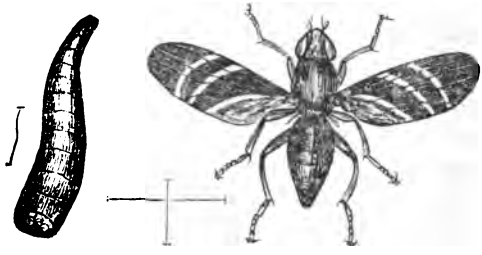

Fig. 83.

Tritoxa flexa, onion-fly. (After Riley.)

Rather large, robust flies, dull ashen gray in color, clothed with stiff bristles or hair, and with spiny legs, larger than the house-fly as a rule, and sometimes even larger than the flesh-fly, are tolerably apt to be beneficial, and include the family *Tachinidæ*. In the entire order there is no group so beneficial to the farmer, and they are almost equal in their importance to the ichneumon-flies belonging to the order *Hymenoptera*. They are usually short, thick-set, of the size already mentioned, and are distinguished from some of the other families by having the bristles of the antennæ entirely bare—that is to say, not clothed with hair. They are usually sober-colored, rarely conspicuous, quick in flying and abrupt in their movements, and frequent flowers and rank vegetation. The larvæ are thick, cylindrical, somewhat flattened

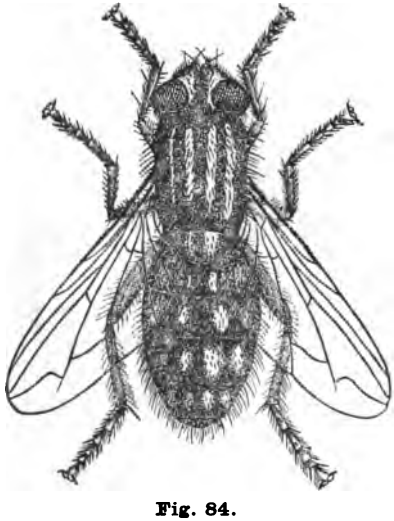

Fig. 84.

The common flesh-fly, *Sarcophaga carnaria;* very greatly enlarged. (From Standard Nat. Hist.)

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below the segments, with transverse swellings for locomotion, and either naked or with bands of fine, short bristles. A very large proportion of them are parasitic upon the larvæ of the *Lepidoptera*, but they also infest grasshoppers, crickets, beetles, *Hymenoptera*, and even some crustaceans and turtles. So far as the farmer is concerned, the insects are chiefly useful to him from their habit of preying upon caterpillars, and it is surprising what an enormous number of larvæ are destroyed every year by these flies. Some of our worst pests are infested by them, and their rank as a check to undue increase is extremely high. Their eggs are white, small, elongate-oval, less than one-sixteenth of an inch in length, and as they are laid on the outside

Fig. 85.

Exorista leucaniæ, army-worm tachinid; somewhat enlarged. (After Walsh.)

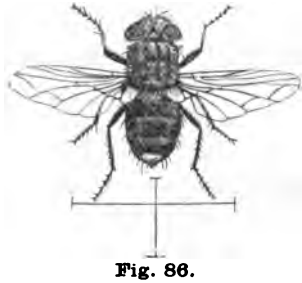

Fig. 86.

Exorista flavicauda, yellow-tailed tachina-fly. (After Riley.)

of the caterpillar are thus readily seen. As a rule the eggs are laid on the back of the larva and close to the head, in such a position that it is absolutely impossible for the caterpillar to get at or to remove them. It is quite a common occurrence to see cutworms with anywhere from one to five or six or more of these white eggs glued to the skin, and every larva so infested is doomed. During the past season, when the "wheat-head army-worm" became so enormously abundant, more than half of the specimens that were sent me contained eggs of tachina-flies. It is rather interesting to watch these flies laying their eggs on the caterpillars. The larvæ seem to realize the fact that they are endangered when they notice the presence of the fly, and will endeavor, by squirming and moving about, to avoid the placing of the egg upon them, but to no purpose. The fly darts upon its prey, the ovipositor slightly extruded, and at a touch the egg is placed. So rapidly is this done that it is difficult to watch the operation, for two or three eggs will be deposited in rapid succession, almost before the

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attention can be centered upon the act. When the eggs are laid the fly leaves its victim to search for others, and the caterpillar, after a vain attempt to get rid of the objects which it feels as a burden, soon resumes its feeding. In a short time the larva hatches, makes its way out of the egg and at once pierces the skin and enters the body of its victim. These tachina-flies never give birth to living young, as is the case with many of the forms that feed in decaying matter, but as a rule the eggs hatch very soon after they have been laid. The little footless maggots feed in the body of the caterpillar, avoiding all the vital points, and subsisting rather upon the juices of their host than upon actual tissue. About the time that their host is full grown they have also become of full size and ready to change into pupæ. As soon as this period arrives, when they have nothing more to gain in the way of food, they pay no further attention to the comfort or well-being of the caterpillar in which they feed, but make themselves comfortable, forming the pupa in the body of their host, and in this process kill it. Anywhere from one to a dozen of these larvæ are matured in a single caterpillar of moderate size, and in large caterpillars, like those of some of our native silkworms, or of the large hawk moths, forty to fifty specimens find sufficient nourishment. As a means of checking the increase of certain forms of noxious insects, nothing could be better than these parasites. The drawback, which I have already mentioned, is in the fact that the caterpillars live out their full life and continue their destruction on the farm crops despite the presence of these creatures in their vitals.

Fig. 87.

Belvoisia bifasciata, banded tachina-fly. (After Riley.)

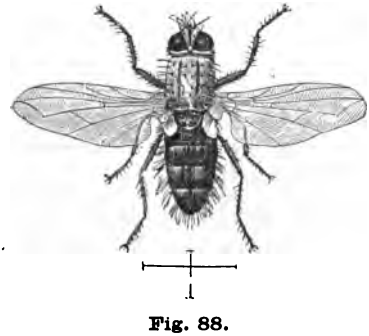

Fig. 88.

Lydella doryphoræ, potato-beetle parasite. (After Riley.)

Another series of flies resembles the house-fly in color and in general appearance, but is very decidedly smaller, and usually as injurious as those previously mentioned were beneficial, although even

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here we have some parasitic species. I refer to the family *Anthomyidæ*. I cannot characterize these insects better than by comparing them, as I have done, with the house-fly, and when, as is sometimes the case, they are found in rooms and on windows, they are usually mistaken for the common pest. Many of these forms feed upon vegetation, and preferably upon roots. In this family come those species which are altogether too well known, as "onion maggots," "cabbage maggots," "radish maggots," and others of similar bad reputation. In their larval form they resemble those that feed in decaying matter, and even those that are parasites, and they feed in much the same way, only, instead of attacking living creatures, as a rule they attack living vegetation. They need not be more fully described here, since none of the parasitic species have any value to the farmers of this State.

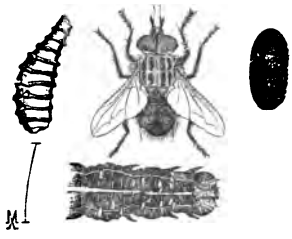

Fig. 89.

Nemorœa leucaniæ: larva, puparium and adult; also forepart of of an army-worm, showing placing of parasitic eggs. (After Comstock.)

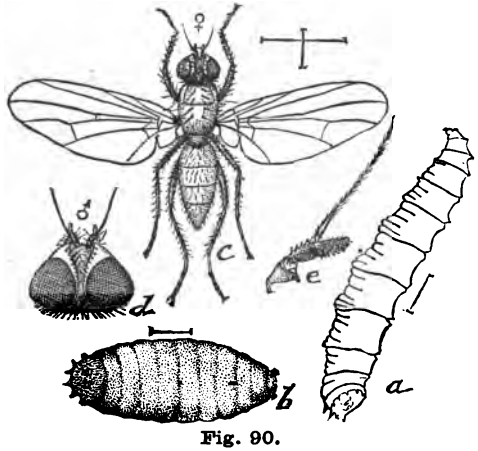

Fig. 90.

THE CABBAGE-ROOT FLY.

Anthomyia brassicæ, Bouche: *a*, larva; *b*, puparium; *c*, female fly; *d*, head of male fly; *e*, antenna. Enlarged.

Next in the series come a large number of other flies, including several families, none of which are in the least beneficial, and most of which are innoxious, though some are positively injurious. Most

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of the species are small, half the size of the house-fly, or even less, and a great many of them are prettily colored. As an example of one of the innoxious forms we may name the little pommace-fly, yellow in color, and with very bright red eyes, which is found in

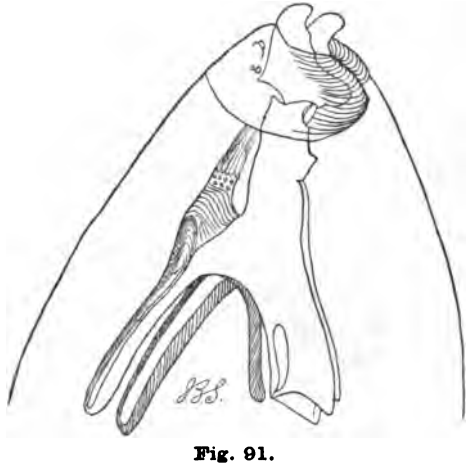

Fig. 91.

Mouth parts of larva of cabbage maggot. (Original.)

such enormous swarms wherever fruit is in a state of fermentation. Where cider is made, thousands of these little flies will gather; where grapes are pressed, swarms are gathered, not only on the skins but in

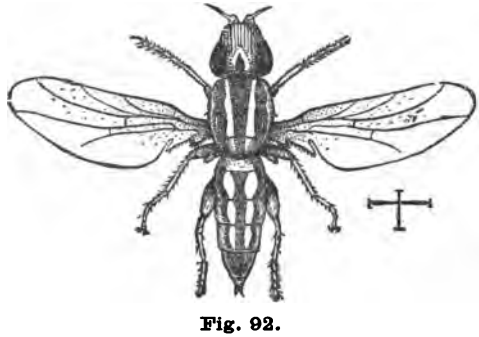

Fig. 92.

Meromyza americana: imago. (After Forbes.)

the fermenting juice. If they are not disturbed, the entire mass of fermenting fruit will soon be filled with little maggots. Others, prettily striped with black and yellow, are more decidedly injurious,

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attacking grains, as in the case of the American *Meromyza*, which causes the silver tip in grasses both cultivated and wild.

We have seen that the order *Diptera* contains a very large number of forms that are either beneficial or at least not harmful to the agriculturist, and we have seen that there are, comparatively speaking, only a few which are anything but friendly to him. The figures that are interspersed in the text are intended to give a general idea of the appearance of the different families that have been mentioned, sufficient to enable an intelligent man to make a close guess at those forms that are of importance to him.

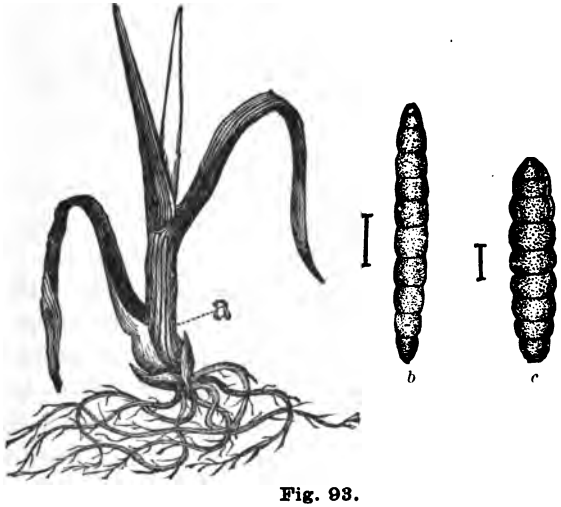

Fig. 93.

Meromyza americana: *a*, location of larva in stem of wheat; *b*, larva; *c*, pupa. (After Fitch.)

The order *Coleoptera*, or beetles, contains a very large number of species, more than ten thousand having been described from the United States alone, and among these we have habits of many different kinds represented. We have feeders upon flesh, feeders upon plants, feeders in wood and feeders in carrion. Some live underground and never come to the surface; some live upon plants in all their stages; some live in water, occasionally spending their entire life under the surface. Whatever their habits, beetles may be always recognized by the horny or chitinous fore wings, forming a shield for the hind wings, which fold under them and are used in flight. The mouth parts are always mandibulate or formed for biting, though sometimes the head

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is prolonged into a beak or snout, at the end of which the organs for chewing are very much reduced and sometimes obsolete. The head is usually distinct, and the prothorax is separate, that is, movable upon the other segments, and is alone visible on the upper side. The transformation or metamorphosis is complete; that is, there is a quiescent pupal stage, in which all the members of the future beetle are separately encased. The larvæ differ so greatly that it will be best to speak of them under the family headings. Among such a mass of forms we have, of course, a great many that are of importance to the agriculturist, either as being beneficial or as being injurious to him. It is somewhat easier to recognize friends and foes in this order, from certain structural characters that can be easily observed, and which will largely determine the character of the insects. As we are more particularly concerned with the forms that are beneficial, it will be well to show first how some of those that are not beneficial may be recognized.

Fig. 94.

Hylesinus trifolii, clover-root borer: *a*, *a*, *a*, burrows of *b*, larva; *c*, pupa; *d*, beetle. (After Riley.)

In the first place none of the snout-beetles or weevils are entitled to be called beneficial insects. While many of them may not be actively injurious yet none of them are actively beneficial. Every insect, therefore, belonging to this order, which is furnished with a snout or beak, whether it be long or short, should be looked upon with suspicion and is never a friend.

Belonging to the snout-beetles, yet with only a very short beak or none at all, are the Scolytids, or bark-beetles, living usually, though by no means always, under the bark of trees, where they or their larvæ make characteristic galleries or borings, emerging from the bark through small, round holes, resembling shot-holes. Very frequently the wood itself is penetrated, and more rarely the insects are root-borers. The beetles are usually small, cylindrical, rather slender and obtusely terminated before and behind, and have a characteristic appearance, difficult to mistake. It is well illustrated in Figure 94, and of course all of these bark beetles are injurious.

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Another series of beetles which contains only injurious or at best innoxious forms, is the *Lamellicornia*. These obtain their name from the peculiarity of the structure of their antennæ or feelers, which terminate in a leaf-like club. This club varies somewhat in size, but is always easily perceptible, and is built as is shown in the accompanying figure. None of the insects are small in size, and some of them are very large. They contain such insects as the "May-beetle," the "rosechafer," and "grubs," and all have approximately the same form, which is well illustrated in the accompanying figure of one of the common May-beetles. A great many of these white-grubs spend all their time underground, feeding upon the roots of plants, and often upon those of cultivated plants. One entire group, however, of quite large extent, feeds rather in decaying vegetable and excrementitious matter, and to this series belong the so-called "tumble bugs" or "pill bugs." These insects derive their name from their habit of forming little balls or pellets of dung, in which they lay their eggs. These little balls or pellets are buried underground a longer or shorter distance, and in them the larvæ develop. Some of the larger forms will roll these pellets for some distance from the place at which they were formed, and they are quite frequently seen on roads, and are well known to almost every farmer's boy who has paid the least attention to what passes before his eyes. These insects of course serve a useful purpose, but can hardly be

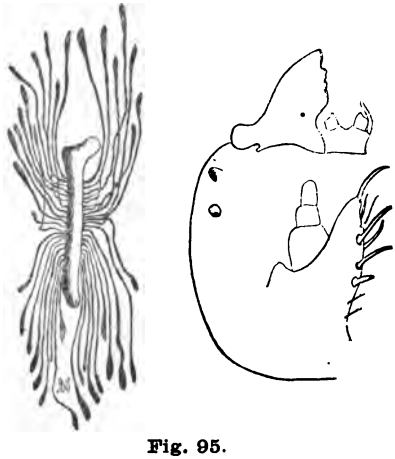

Fig. 95.

Burrow of the hickory-bark borer, *Chramesus icoriæ*, and mouth structures of the larva. (Original.)

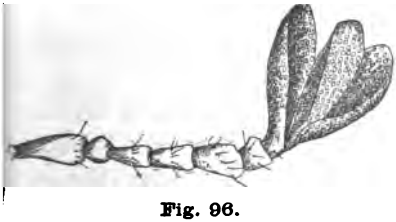

Fig. 96.

Antenna or feeler of a lamellicorn, showing the sensory pits of the leafed club. (Original.)

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called beneficial, and they are in company with so many forms that are actively injurious that they do not serve to redeem the entire group to which they belong, from condemnation. No insect that has a lamellate or leaf-shaped antennal club can be considered as friendly to the farmer, and should always be looked upon with suspicion.

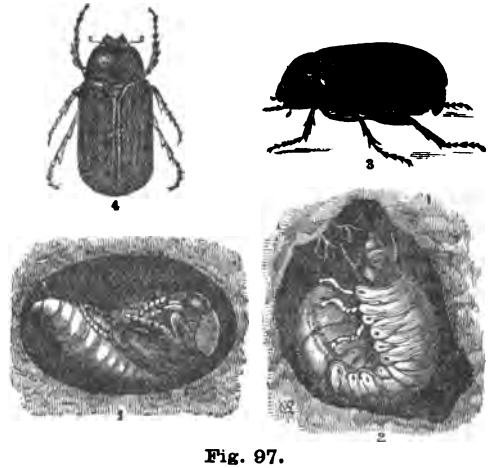

Fig. 97.

The common May-beetle, *Lachnosterna fusca: 1*, the pupa; *2*, the larva or white-grub in its ground cell; *3* and *4*, the beetle, side and dorsal views. (After Riley.)

The character of the tarsi, or feet, is one that is used very largely in separating beetles and in dividing them into great series, and this will serve us somewhat conveniently for separating off another large lot of insects that are essentially feeders upon vegetation. The legs of all insects are formed approximately as shown in the figure herewith given, in which the parts are named. We have first, at the extreme base, the coxa, which joins the rest of the leg to the body, and this is rarely a prominent feature. Following this comes the femur, or thigh, which is usually the stoutest part of the entire leg, and contains the muscular structures, or most of them, at least, and connecting this with the coxa is usually another

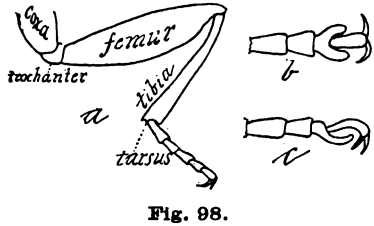

Fig. 98.

a, illustrates a normal insect leg with all the parts named, the tarsus five-jointed; *b*, four-jointed tarsus, third joint lobed; *c*, same from side. (Original.)

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small piece, the trochanter; next, we have the tibia, or shank, and, finally, we have the tarsus, or foot, which is composed of a number of joints, varying in the beetles from three to five. In a large series of beetles we find that this tarsus is composed of four joints, apparently, and that the third joint is lobed or divided into two parts, from the center of which a claw joint arises. The figure herewith given illustrates a tarsus built on that style, and all the insects with feet of this description can be considered as enemies, or, at least, no

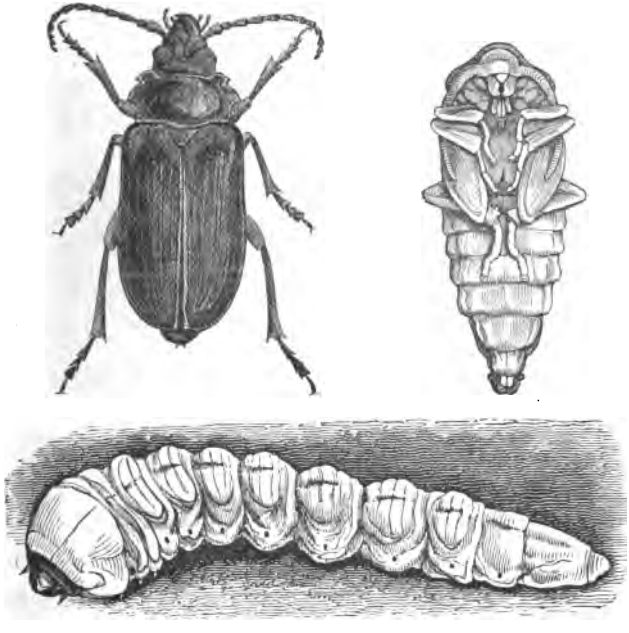

Fig. 99.

The giant root-borer of grape, blackberry, etc., *Prionus laticollis:* larva, pupa and imago. (After Riley.)

active friends of the farmer. The very great majority of them feed upon plant tissue, and none of them, so far as I am able to recall, are either parasites or predaceous. Two large families are so characterized, the *Chrysomelidæ* and the *Cerambycidæ*.

The *Cerambycidæ* are rather readily recognized by their oblong, often cylindrical bodies, the long, filiform or thread-like antennæ, which are rarely shorter than the body and sometimes more than

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twice as long, and by the powerful in-curved mandibles. Their long feelers have led to their being called longicorns and capricorn-beetles. The larvæ are long, fleshy, slightly flattened or cylindrical, often footless, whitish grubs, with very convex rings or segments. The head is very small, but is armed with strong, gouge-like mandibles, adapted for boring like an auger in the hardest woods. They live, generally, in the woody tissue of plants, and almost all varieties of trees are attacked by them. Not only trees, but many kinds of shrubs and cultivated vines and plants are infested by some of the species. Blackberries, currants, raspberries, grapes and plants of that description are all attacked by these long-horned beetles. Occasionally, herbaceous plants, like milkweed, for instance, are infested; but not a great many species have this habit. Most of them, like the "apple-borer,"

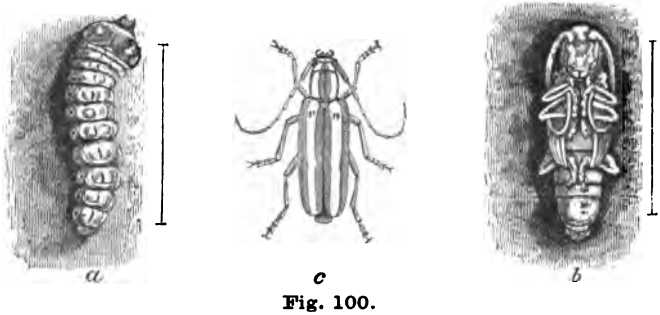

Fig. 100.

Apple borer, *Saperda candida*: *a*, larva; *b*, pupa; *c*, beetle.

live in wood and frequently do a great deal of mischief. Quite usually, the first body segments are larger than any of the others, and the swelling is sometimes so abrupt that it looks as if it really formed part of the head of the insect. None of the members of this family can, by any possibility, be considered as beneficial.

The *Chrysomelidæ* are leaf-feeding beetles, and contain only injurious forms. To this family belong the Colorado potato-beetle, our various flea-beetles, the elm-leaf beetle, the striped melon-beetle, the "tortoise-beetles" and others with similar habits, and the insects mentioned will serve also to give an idea of the variation in form which is found within this family. In some cases it becomes rather difficult to distinguish members of this family from that immediately preceding, but such forms are rarely met with and may be left out of consideration here, entirely. As a rule the beetles are oval or oblong, often

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very thick and convex, with short antennæ, rounded, prominent eyes, and a variable thorax. Sometimes, as in the flea-beetles, the posterior legs are very much developed and formed for leaping. The jaws are usually rather small, and are more or less scoop-shaped and formed for masticating leaf tissue. The larvæ are short, rounded, cylindrical or flattened, sometimes very much elongated and slender,

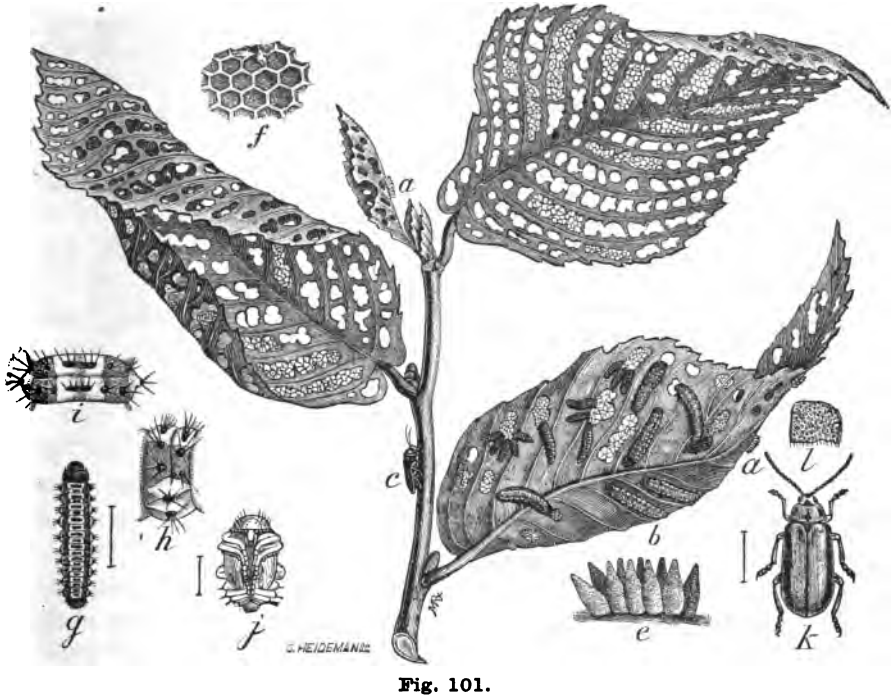

Fig. 101.

Elm-leaf beetle: *a*, eggs; *b*, larvæ; *c*, adult; *e*, eggs, enlarged; *f*, sculpture of eggs; *g*, larva, enlarged; *h*, side view of greatly-enlarged segment of larva; *i*, dorsal view of same; *j*, pupa, enlarged; *k*, beetle, enlarged; *l*, portion of elytron of beetle, greatly enlarged. (After Riley.)

generally of a soft consistency, often gaily colored, sometimes beset with thick, flattened tubercles or branching spines, and nearly always with well-developed feet. In the larvæ of the potato-beetle and the asparagus-beetle we have modifications of one type which are familiar to most farmers. In the elm-leaf beetle, which is also well known, we find another somewhat modified form, while in the larvæ of the striped melon-beetle we find a slender type resembling in miniature a wireworm, except that the texture of the body is soft. A some-

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what interesting form is that found in the sweet potato "golden-beetles," which are oval and flattened and with curious anal processes. Quite usually the larvæ feed freely on the outside of the leaves, but

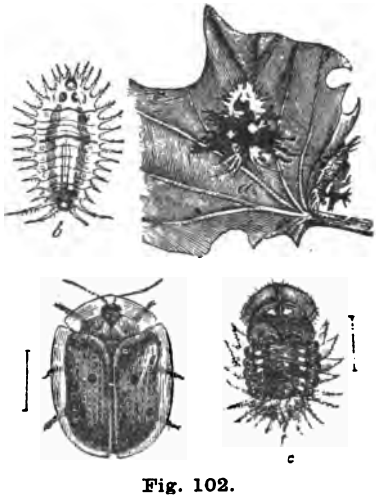

Fig. 102.

Sweet-potato beetle: *a*, larvæ on leaf; *b*, larva; *c*, pupa; *d*, beetle. *b*, *c*, *d*, enlarged.

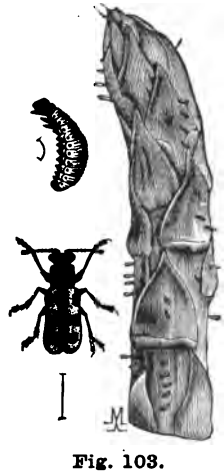

Fig. 103.

Asparagus-beetle: eggs, larva, adult. (After Comstock.)

not unusually they feed underground on the roots of plants, and sometimes, as in the case of some flea-beetles, they feed within the tissue of the leaf and are miners.

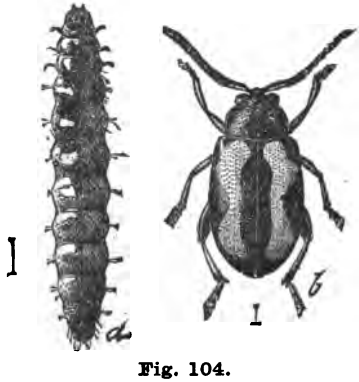

Fig. 104.

Striped flea-beetle, *Phyllotreta vittata*: *a*, larva; *b*, adult. Both greatly enlarged. (After Riley.)

Another set of beetles that we can separate off without very much trouble is the *Elateridæ* or "snapping-beetles," or "click-beetles," as they are often called. In these insects the antennæ are serrated or saw-toothed, and the head is small and retracted. The tarsi or feet are five-jointed in this family, and none of the joints are lobed. It may be said in a general way here, that this combination of a five-jointed tarsus and a serrated or toothed antenna, when found in a beetle, indicates that the species is

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one which should be regarded with suspicion. It is usually a feeder on vegetation, and not often to be classed as friendly. There are some exceptions, however, which are hereafter mentioned. The prothorax in these snapping-beetles is loosely articulated to the rest of the body, and on the under side or breast there is a curved process which extends backward and fits into a groove between the second pair of legs in such a way as to enable the species to leap in the air by a sudden jerking movement, which has been described as follows: "They possess the singular power of springing in the air when placed on the back. This is effected by extending the prothorax so as to bring the prosternal spine to the anterior part of the mesosternal cavity, then suddenly relaxing the muscles so that the spine descends violently into the cavity. The force given by this sudden movement causes the base of the elytra to strike the supporting surface and by their elasticity the whole body is propelled upward." The beetles are thus easily recognized, and the larvæ are no less marked. They are generally known by the name of wireworms, and are vegetable feeders, living on the

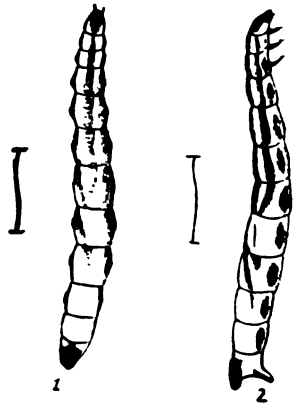

Fig. 105.

Diabrotica vittata, larva of striped melon-beetle: *1*, from above; *2*, from side. Enlarged.

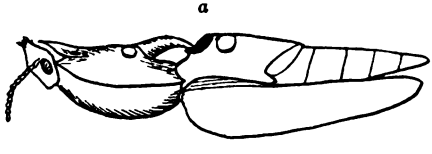

Fig. 106.

Snapping-beetle, showing the prosternal spine at *a*. (Original.)

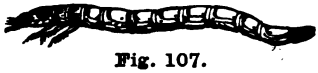

Fig. 107.

Wireworm, natural size.

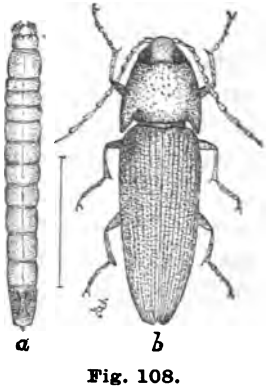

Fig. 108.

Common snapping-beetle, *Melanotus communis*: *a*, larva; *b*, beetle. (From Bruner.)

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roots of grasses, corn, potatoes, turnips and other field crops and garden vegetables. The eggs are laid, preferably, in pastures and fallow ground where the surface is undisturbed, or in the vicinity of or in rotten wood, in which some of the species feed. The larvæ of many species live several years. They are very long, cylindrical and hard-bodied, whence their name "wireworm," and generally pale yellow or yellowish red in color. They have six distinct true legs and a small anal prop leg. The body is flattened somewhat towards the head and tail. These insects are very well and not too favorably known to the farmers, and I have never heard of their being regarded in the light of friends.

Another family which affords the same structural combination of serrated antennæ and five-jointed tarsi is the *Buprestidæ*, for which we have no common name. The beetles somewhat resemble those of the preceding family, but have not the power of springing, and they are generally shorter and broader. Most of them have the outer body very hard and tough, and usually the colors are metallic, often with a golden or bronze luster. Occasionally the species are more cylindrical, as with the red-necked blackberry-borer, which will serve fairly well as the type of one section of this family. The more usual form, however, is that which we find in the flat-headed apple-borer, a picture of which is herewith given. The larvæ of these insects are wood-feeders, as a rule, using this term in a somewhat loose way, and they are generally somewhat flattened, the segments well marked, the body much elongated, the head small, with powerful jaws, the first body segments much enlarged. They have somewhat the form of the larvæ of the long-horned beetles or *Cerambycidæ*, but can always be distinguished from them by their more flattened body and flat head. The larvæ more generally feed in the sap wood, forming channels under the bark, and do not so generally bore into the heart of the tree itself, as is the case with the other family. In some cases the larvæ of the smaller species are leaf-miners, living in the tissue between the upper and under surfaces.

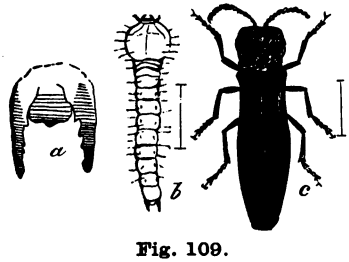

Fig. 109.

AGRILUS RUFICOLLIS, Fabr.

Larva and beetle, enlarged. (After Riley.)

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We have now separated off, in a general sort of way, those families and series which contain most of our injurious and few or none of our beneficial species among the beetles, and they form a large part of

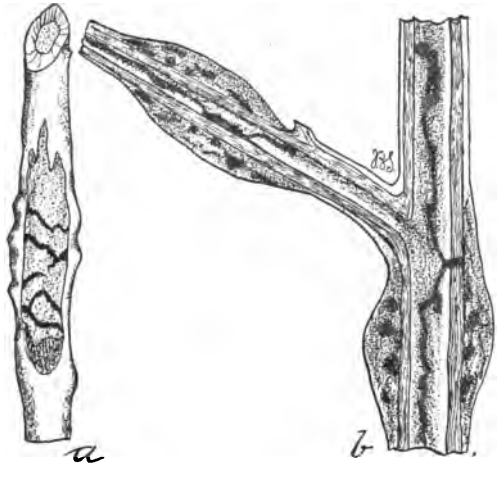

Fig. 110.

Gall of red-necked Blackberry borer: *a*, section through galls on main cane and lateral, showing the track of larva through the bark and pith, and pupal cell; *b*, tracks of young larvæ. (Original.)

the entire order; but there are yet a greater number of families that are either indifferent to the farmer or contain only a few that are sometimes troublesome or that are positively beneficial. Following out the plan of separating off those forms that are most easily recognized, we next come to what are usually called "fire-flies" or "lightning-bugs." The appearance of these insects is quite well known to almost every observer. They are generally elongated, rather slender insects, and the wing covers, indeed the entire outer coverings of the body are soft, never hard as in the preceding families. The antennæ are serrated or saw-toothed, and the tarsi are five-jointed, coming under the general condemnation previously made; but they differ, so far as tarsal structure is concerned, from the families last spoken of

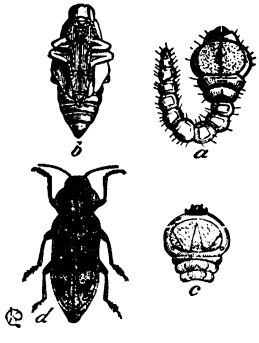

Fig. 111.

Chrysobothris femorata: *a*, the flat-headed apple borer; *b*, pupa; *c*, under side of head and thoracic rings; *d*, beetle. (After Riley.)

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by having the fourth joint lobed somewhat similar to the lobe of the third joint in the *Cerambycidæ*. The curious feature in this family, from which it has received its common name, is the power that many of them have of emitting a flash of phosphorescent light at the will of the insect. These light-bearing organs are usually on the last segments of the abdomen, and when not in active use appear of a sulphur-yellowish color. In some cases, however, the larvæ, and the females

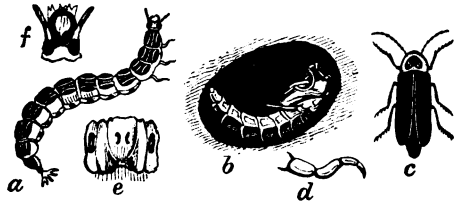

Fig. 112.

Photinus pyralis, fire-fly: *a*, larva; *b*, pupa; *c*, beetle; *d*, *e*, *f*, parts of larva. (After Riley.)

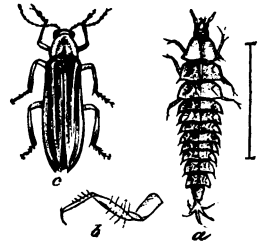

Fig. 113.

Photuris pennsylvanicus, fire-fly: *a*, larva; *b*, its leg; *c*, beetle. (After Riley.)

where they do not obtain wings, have luminous spots along the sides as well, and such forms, when they are noticed in the grass, are called "glow-worms." The larvæ are rather long, flattened, blackish, with the edges of the segments well marked, and many of them live on snails or other creatures of that character, though probably attacking insect larvæ as well in some cases. Thus, while they are not injurious they are not strictly beneficial and they need not be regarded by the farmer as of particular interest to him.

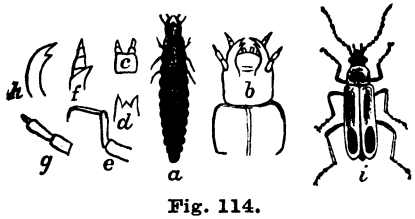

Fig. 114.

Chauliognathus pennsylvanicus: *a*, larva, natural size; *b*, head and first segment of same, enlarged; *c*, labium; *d*, labrum; *e*, leg; *f*, left maxilla; *g*, antenna; *h*, left mandible; *i*, imago. (After Riley.)

A nearly allied family is the *Telephoridæ*, which, in general appearance and in texture, resembles the fire-flies. The head, however, is more prominent and larger, the eyes distinct and globose and the thorax parallel. None of these have the power of emitting light, although, as has been said, they resemble the fire-

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flies. Among the most common species is the so-called "soldier-beetle," *Chauliognathus*, which is very abundant on flowers. There are really two species of these soldier-beetles, one appearing in spring and another in fall; but they resemble each other so much in appearance that for all practical purposes they may be considered as one. The larva of this insect has, in a general way, the shape of the fire-fly larva, but is somewhat more slender. Its habits are also predaceous; but it feeds upon insect larvæ which it finds in the ground, and it has been noticed devouring that of the plum-curculio, which at once stamps it as a beneficial insect. This forms an exception to the rule previously mentioned, and the soldier-beetles and their larvæ must be considered as friends. In the accompanying figure, the appearance of both the larva and the beetle is shown. The larvæ live only on the ground; the beetles, on the contrary, frequent flowers. The form that appears in spring can be found on blossoms of all kinds; the form that appears in fall favors golden-rod, where it can often be seen in very large numbers. Common as these insects are, they are, undoubtedly, an important factor in nature's battery for checking the increase of species that feed upon vegetation, and they should be recognized as friends. Other species of the *Telephoridæ* have similar habits; but they are rarely common, and mostly frequent wood-lands, finding their prey in species other than such as are injurious to the farmer.

Another small family that belongs close to this place is the *Malachidæ*. The insects somewhat resemble those of the previous family, in so far that the body texture is soft and the wing covers are not hardened. They are, however, very much shorter and the body is decidedly broader. The feelers are also short and a little enlarged toward the tip; in the males, often curiously knotted in the middle. They are found on flowers, sometimes not uncommonly, and they feed on other insects and insect eggs, probably doing a great deal of good in that way. The larvæ of only a few species are known, and so far as we do know anything of them, they are also predaceous, and feed on quite a variety of other insects.

The family *Cleridæ*, comprising the "flower-beetles," belongs to this same series, but is distinguished in the classification by the fact that the tarsi have the joints furnished beneath with membraneous appendages. The more common species are not unlike the members of the previous family, but they are throughout of a firmer consist-

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ency, never soft or with shortened wings. The head is generally large, the eyes prominent, the antennæ being of good size and quite frequently with a more or less distinct club at the tip. The beetles are often prettily banded, red and black, yellow and blue, and the colors are sometimes strongly contrasting, making the insects rather conspicuous on the flowers that they frequent. While most of the species may be found upon flowers at some time—and many of them are rarely found elsewhere—yet they do not breed upon flowers, and the larvæ are carnivorous and sometimes partly parasitic. In a very few instances the larvæ feed upon dead animal matter; but these cases are exceptional. In form, the larvæ are rather elongated and slender, somewhat depressed or flattened above, the segments well marked, the head quite prominent and the end of the body frequently furnished with anal forceps. The habits of these larvæ differ quite widely; but there are two main lines along which they work. One series of them infests the nests of bees, the eggs being laid by the beetles in or near the nests themselves. The larva, when hatched, first devours the grub of the bee in the cell in which it is born, and then proceeds from cell to cell, preying upon the inhabitant of each until arrived at maturity. It is in this situation, also, that it undergoes its changes in a small cocoon which it has previously constructed, making its escape from the nest in the beetle state when the hardness of its covering sufficiently defends it from the sting of the bees. Another series lives in the galleries of wood-boring beetles, and more particularly those of the scolytids, which make the peculiar and sometimes very complex galleries under the bark of trees, and clerid larvæ are really the most important checks to the ravages of these bark-boring beetles. The shape of the clerid larva is such that it is able to work its way along the narrow passages made by the borers, and there it devours the eggs where such are in the burrows, or, if they have already hatched, the young larvæ, and in fact the larvæ of any stage, are welcome morsels. It

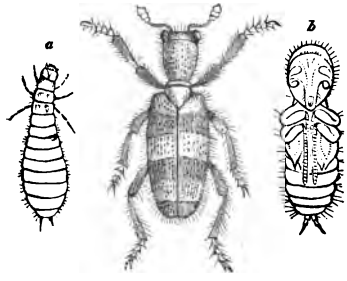

Fig. 115.

Bee-devouring flower-beetle, *Clerus apiarius: a*, its larva; *b*, pupa. Enlarged. (From "Packard's Guide.")

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is one of these species, *Clerus formicarius*, that is supposed to keep in check the destructive bark-boring beetles of Europe and to prevent serious injury by them. Our own species are known to have similar habits, and particularly *Clerus nigripes*, but it has been proved positively that under the circumstances as they exist in our country our species are not able to keep down the bark-borers within what may be considered reasonable limits. It has been therefore attempted to introduce the European species in this country, and the Entomologist of the Virginia Experiment Station has imported a very large number of specimens in all stages, which have been turned loose in the forests that have suffered so seriously of late years from some of the bark-borers. The experiment is a very interesting one and offers some chance of success, unless the same causes that operate to prevent a sufficient increase of our own species also prevent the increase of these imported forms, which would be thus an assistance to our own species without accomplishing entirely the result hoped for. One thing must be taken into consideration in estimating the value of this insect, *Clerus formicarius*, in Europe, and that is that their methods of forestry are such that the bark-boring beetles have at best a difficult task to get along. Dead and dying timber is felled and removed; no fallen branches are allowed on the ground, and stumps are taken out before they can become infested by the bark-borers. Man here does his best to prevent and check the increase of the injurious forms, and those species that feed upon them have a comparatively easy task in finding the few burrows that escape, and in destroying the larvæ. This makes bark-borers rare, comparatively speaking, and therefore little or no injury is done by them. In our own country, matters are unfortunately in quite a different state. Nothing like a science of forestry is practiced in most localities; dead trees are found everywhere; sick and dying trunks are left unregarded; others are felled, and stumps are allowed to remain in the ground until they rot; branches that are not needed are left where they have been lopped off; in fact, every possible opportunity is given the injurious species to continue their kind, and it need scarcely be said that they take advantage of the opportunities offered them. This enables them to increase at an unusual rate, and when they become so abundant that dead and dying wood fails them they attack that which is living, and frequently acres upon acres are ruined. Now in cases of that kind the *Cleridæ*, however active they may be, are really

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helpless, because they cannot increase with sufficient rapidity. There is only one brood of them in the course of the year, and the insects are not very prolific; that is to say, the female does not lay a large number of eggs. They therefore increase much more slowly than do the insects upon which they feed, and though they might in the event conquer them, yet it would not be until the bark-beetles themselves were running out of food, and their increase was checked by natural causes. Useful as these clerids undoubtedly are, yet they have no very high value to the farmer in this State, since they do not feed upon any of the pests that infest his field crops.

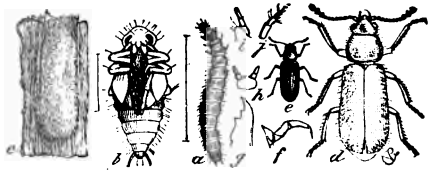

Fig. 116.

Red-legged ham-beetle. *Corynetes rufipes:* *a*, larva; *b*, pupa; *c*, cocoon; *d*, *e*, beetle, enlarged and natural size; *f* to *j*, structural details. (After Riley.)

One little group of this family is quite unlike any of the others in appearance and habits, and feeds upon dead and dying animal matter, often attacking provisions, and of this type the red-legged ham-beetle, *Corynetes rufipes*, is a good example.

There is one more family of insects in which the antennæ are serrated or saw-toothed which it may be advisable to mention, and that

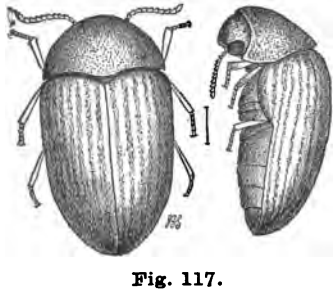

Fig. 117.

Lasioderma serricorne, "cigarette-beetle." (Original.)

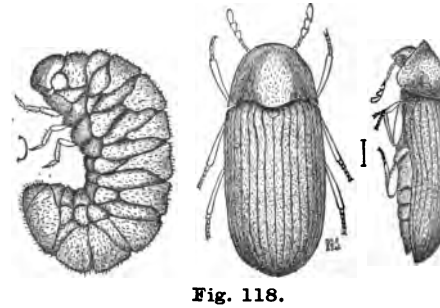

Fig. 118.

Larva and beetle of "death-watch," *Sitodrepa panicea*. (Original)

is the *Ptinidæ*. These are all small, and sometimes very small insects, often of odd shapes, and most of them feed both in the larval and beetle stage on dead or dying animal and vegetable matter. In some cases, however, living vegetation is also attacked, and none of

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the species can be considered in any sense of the word as beneficial. It is the beetles belonging to this family that we find sometimes in stored vegetable matter, and occasionally boring in our furniture, and particularly in rattan or willow ware. A well-known type is the tobacco-beetle, or "cigarette-beetle," on the one hand, and the "death-watch" on the other. This "death-watch," being so called from the habit it has of causing a ticking sound by striking its head or thorax against the wood in which it feeds, causing a sound like the tick of a

Fig. 119.

Work of tobacco-beetle in cigars. (From a photograph.)

watch. When heard in old houses, superstitious people have believed that this is a sign to announce the death of those who hear it. As a matter of fact, it is only the call of the insect to its mate. The larvæ of these insects have somewhat the appearance of minute white grubs, and the appearance of some of the forms is shown in the figures given herewith. As the family contains no beneficial insects, it need not be considered further just at present.

In the great series of beetles which have the antennæ terminated by a more or less distinct club we have a very large variety of forms, with an equally large variety of habits, and some of these are bene-

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ficial, a few are injurious, while the most of them are indifferent; that is to say, neither advantageous, nor on the other hand troublesome. In fact it may be said that there are no species in this series which are seriously injurious to growing vegetation, although many of them are troublesome to stored products. On the other hand, some of our most active beneficial insects belong to this series, and in this instance I will first mention those forms that are beneficial, then those that are more or less troublesome, leaving it to be inferred that all the forms that are not specially mentioned are indifferent.

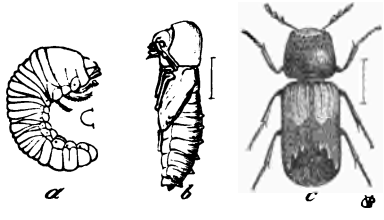

Fig. 120.

Red-shouldered sinoxylon, *Sinoxylon basillare: a*, larva; *b*, pupa; *c*, imago. (After Riley.)

First in the series are the *Staphylinidæ*, or "rove-beetles." They are easily recognized by their long, linear, black or brown bodies, with remarkably short elytra or wing covers, and seven or eight visible horny abdominal segments. Though sometimes an inch in length, they are more commonly minute, inhabiting wet places under stones, manure heaps, fungi, moss, under the bark or leaves of trees, or sometimes in the soil itself, apparently without direct shelter. Quite a number inhabit ants' nests, and some species are never found except in such places. The larvæ closely resemble the beetles, being narrow, the segments of very equal size, the terminal ring forming a long prop leg, but of course there are no traces of wings. The larvæ are found in much the same positions that we find the beetles, and have very similar habits. While the vast majority of the species undoubtedly feed upon dying or decaying vegetable matter, including in that term excrement and fungi, yet some of them are undoubtedly carnivorous, and feed upon quite a variety of insects that they find in the ground. Members of this family are never injurious to crops in our State, and where they are not directly beneficial by feeding upon the enemies of the farmer, they are almost all indirectly

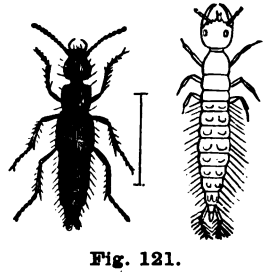

Fig. 121.

Rove-beetle and larva. (After Riley.)

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beneficial by assisting in removing decaying matter, sometimes animal as well as vegetable, and in preparing it for assimilation by the plants. No beetles, therefore, that answer to the description above given should be interfered with, nor should they be suspected of injury.

The next family that requires consideration is the *Coccinellidæ*, or "lady-birds," as the insects are generally called. The characteristic form of these insects is well known. They are usually very convex, sometimes almost hemispherical, generally red or yellow, with round or ovate black spots, but sometimes black, with or without yellow or red spots. The antennæ are short, as are also the legs, and the insects move about only slowly. The eggs are yellow, long and oval, and are laid in patches on the under side of leaves, generally those that are infested by plant lice. The larvæ are rather long, oval, soft-bodied, and pointed behind. They are often gaily colored, black, brown or blue, with contrasting yellow or white or red spots or blotches, frequently beset with tubercles or spines. When changing to a pupa the larva attaches itself by the end of the body to a leaf or twig, and either throws off the larval skin, which remains around the tail, or the old dried skin is retained, loosely folded about the pupa as a protector. With one exception, the species of the family that occur in our State feed, both in the larval and adult stages, upon plant lice, and are thus of the highest possible importance to the agriculturist. In order that the species may be recognized by the farmer, a somewhat more full account will be given of these insects than has been given of any of the previous series.

In the typical genus, *Coccinella*, we have forms that are almost hemispherical, and one of the most common as well as the most useful of our species is the *C. 9-notata* or the "nine-spotted lady-bird." This is nearly one-quarter of an inch in length, although many specimens are decidedly smaller, has a black thorax, margined in front with white or yellowish, and has the wing covers yellow or orange, with five black spots on each. One of the spots, however, is exactly on the line where the two wing-covers meet, so when they are closed it appears as a single spot only, and we have therefore nine spots on the wing-covers. This insect is found everywhere, and feeds on almost all kinds of plant lice. It is really the most general feeder in this respect that we have, and it is correspondingly useful. I may say, indeed, that it is the most useful of all the lady-birds in this State, and I have found it feeding upon almost all the species of plant lice

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that infest cultivated plants. Its larva agrees in general shape with the figure that is herewith given, and is dark in color, very little relieved by bluish and orange spots. In fact so marked is the general dark color that the larvæ are locally known as "niggers." It is not at all unusual for me to receive these larvæ as the parents of the plant lice, and very few farmers recognize them as their best and most active friends. The advantage of this insect over the many parasites that infest plant lice is that when a specimen is seized its life is ended, and it does no further feeding. It is quite remarkable what a great number of aphids a single one of these larvæ is able to devour, and they seem to be constantly hungry and constantly feeding. I have seen two of them, on a head of wheat, clear off, in the course of twenty-four hours, every solitary louse to be found on it, and in some respects they exercise a rather nice discrimination, for I have noticed that they will not attack lice that have been parasitized, and in which the parasite is full grown. Thus they permit the development of at least a portion of the parasites, while they themselves destroy an astonishing number of these enemies of the farmer. The insects have the further advantage of several broods in the course of the year—how many I cannot say, but they certainly seem to be breeding throughout the entire season, and eggs, larvæ and imagos may be found during almost the entire summer. This enables them to increase at quite a rapid rate when food is abundant, and, usually after midsummer, they become numerous enough to get the better of any lice that they are feeding upon. Unfortunately the larvæ of the lady-birds are themselves subject to parasitic attack, and we frequently find full-grown larvæ which had apparently been ready to pupate, fastened by the tail, but with an ugly hole in the side which showed where the parasite had emerged. The insects pass the winter in the beetle state, and this season is very hard on them, by far the greater number dying either from cold or from other causes of which we know little or nothing, so that comparatively only a few specimens may be found to continue the species in the spring. It has been sug-

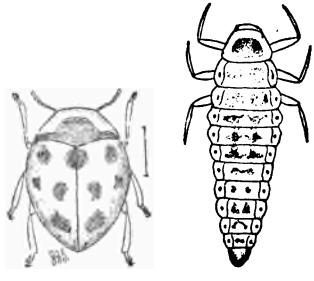

Fig. 122.

Nine-spotted lady-bird, *Coccinella novem-notata*, and larva, enlarged. (Original.)

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gested, by others as well as myself, that possibly some advantage might be derived from collecting a number of these insects in the latter part of the summer, when they are very abundant, and keeping them at an even temperature during the winter. We might then be able to turn them loose in the spring, getting in this wise a very large proportion of insects safely through the dangerous season, and giving them a good start in the spring. No direct experiments have been made to my knowledge to prove or disprove the feasibility of this proceeding, but it is at all events worthy of trial and might possibly result beneficially.

A much smaller insect, although of very much the same shape and belonging to the same genus, is the *C. sanguinea*, which is easily distinguished from the preceding, not only by its size but is unlike all

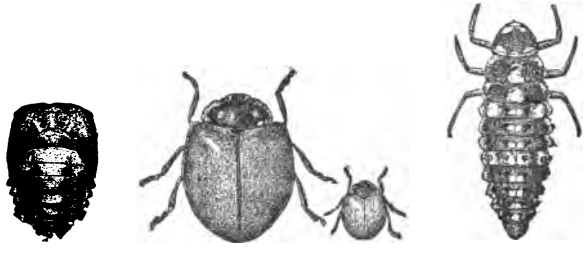

Fig. 123.

Cycloneda sanguinea: larva, pupa, imago. Enlarged. (After Comstock)

others of our species in that it has the wing covers varying from yellow to blood red, without marks of any kind. This is also an extremely useful form, though it is decidedly less abundant than the other, and is not nearly so general a feeder. Its larva, however, is very commonly found among colonies of plant lice and is a worthy assistant to the species previously mentioned. Its habits are so like those previously described that nothing further need be said on this head.

A nearly-allied species to the last, but belonging to the genus *Adalia*, is the two-spotted lady-bird, *A. bipunctata*. This is a little larger and a little more oval in outline than the preceding, with the same general color appearance, but with one black spot on the middle of each wing cover, and from this its name, the "two-spotted lady-bird," is derived. This is found everywhere, and it is the species

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that is most usual in garden plots, often entering the houses and feeding upon the plant lice found on potted plants in windows and rooms. Perhaps this little creature is the best known of the lady-birds to the ordinary observer. It is not so effective in the field, however, as the species previously mentioned, though it does its share in the good work, to the best of its ability.

We have several species belonging to the genus *Hippodamia* which are distinguished by their more elongated, oval outline, and somewhat less convex appearance. Our most common form is the *H. convergens*, or convergent lady-bird. This has a black thorax with the front and sides white-margined and two little white marks converging posteriorly on the disk. On each wing-cover there are six small black dots, and there is a seventh on the edge where the elytra join, making it appear as a single spot when the wings are closed. There are thus, apparently, thirteen small black dots on the wing-covers, which otherwise are orange in color. This makes the species an easily-recognized one, and it also is abundant on all sorts of field plants, feeding upon the aphids. It is especially abundant on melons and on other allied plants, and does yoeman duty in lessening the number of melon lice. A very worthy associate is the glacial lady-bird, *H. glacialis*. This has a thorax very like the preceding, but the wing-covers have a broad band posteriorly, a large black spot near the apex of the wing-covers and often a small black dot on the shoulders. It is also quite considerably larger than its ally, but has exactly the same habits and is also one of the common species feeding upon the melon louse.

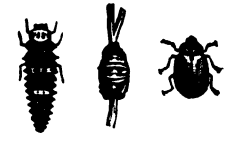

Fig. 124.

Convergent lady-bird, *Hippodamia convergens:* larva, pupa and adult. (After Riley.)

Fig. 125.

The glacial lady-bird, *Hippodamia glacialis.* (After Riley.)

Another species belonging to a very closely-allied genus is the *Megilla maculata*, which is more slender than either of the species heretofore mentioned, and has the thorax and wing-covers a bright but deep red, verging towards carmine. On the thorax are two large black spots, and on the wing-covers are six large black spots, of which two are on the edges of the wing-cover, so when the wings are closed there appear to be ten spots. This deep-red color and the very large spots make the insect an easily-recognized one. This is also a very

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common species, but it is more usually found on wild plants, feeding upon the lice which infest them, although it very frequently appears in our fields, and always as a friend. The rapidity and thoroughness with which these species of lady-birds sometimes work was extremely well illustrated in a large melon-field which I examined three years

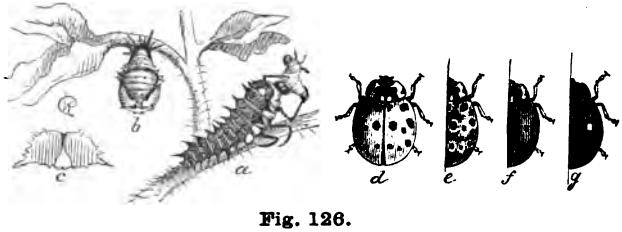

Fig. 126.

Fifteen-spotted lady-bird and varieties: *a*, larva; *b*, pupa; *d*, beetle. (After Riley.)

ago at Esopus, N. Y. This field of thirty acres, all in cantaloupes, had become infested by the melon louse at one corner, and the insects had swept along, taking nearly half of it before the lady-birds got a fair start. In September, when I visited the field, I found that where the lice had first started they had been entirely destroyed by lady-birds, nearly all of them belonging to the species which I have described, and that they were rapidly getting the advantage of the lice in every direction. A great part of the field had been entirely freed from them, and larvæ and beetles were among their prey everywhere, and were busily engaged in feeding. Unfortunately, however, the damage had already been done, and, busy as the insects were in devouring their prey, they could not restore the melons that had been destroyed. Thus, no matter how effective such insects may be, they can never replace to the farmer what is once lost, nor can they be used as a substitute, in any sense of the word, for an active, intelligent campaign by the farmer himself.

Fig. 127.

Megilla maculata. (After Riley.)

We have others of the lady-birds that feed on plant lice, but generally upon species that are not troublesome to the farmer. One series is quite a general feeder upon scale insects. These are very much smaller species, as a rule very convex insects, and they are black, often spotted with yellow or red. In this series the larvæ become spined or provided with tubercles of various forms, and they

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are somewhat more slug-like in appearance. They belong largely to the genera *Hyperaspis* and *Brachyacantha*. Still another series, also useful in feeding largely upon scale insects, are very small black species belonging to the genus *Scymnus*. Many of them are clothed with fine hair, differing thus at once from all those previously described. These are difficult to distinguish, and as they have comparatively little interest to the farmer, we need not pause to describe them particularly. The general life history of all these species is the same, and, so far as I am aware, all of them pass the winter in the beetle stage, hidden away in crevices, under bark, among rubbish—indeed, wherever shelter of any kind exists—and it is during this season, as I have already stated, that the great loss in numbers takes place that puts these insects at a disadvantage in their start in spring.

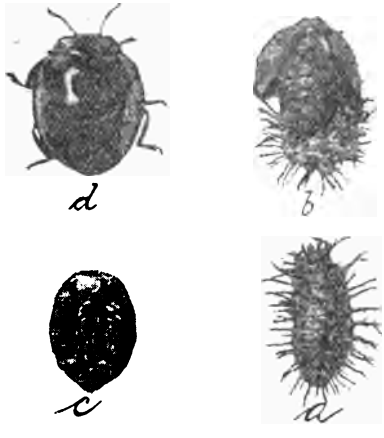

Fig. 128.

Boreal lady-bird, *Epilachne borealis*: *a*, larva; *b*, *c*, pupa; *d*, adult. (Original.)

As there is no rule without exception, so, unfortunately, there is one instance in our State of a lady-bird that is injurious instead of beneficial. This is the boreal lady-bird, *Epilachne borealis*, which is also called the "squash lady-bird," from its habits of feeding upon the squash plant, both in the larval and adult states. This insect has been described at some length in previous reports, and in Bulletin No. 92 of the Station. It is quite remarkable that we should have, in a family so generally beneficial, this peculiar exception; there being in our country, in the entire series, only three species out of one hundred and forty that feed exclusively upon vegetation, all others being distinctly beneficial. Lady-birds, then, with a single exception only in our State, should be encouraged at all times, and should never be destroyed or interfered with in any way.

It may be advisable, also, to record the fact that aberrations of taste are sometimes found, even in those species of lady-birds that

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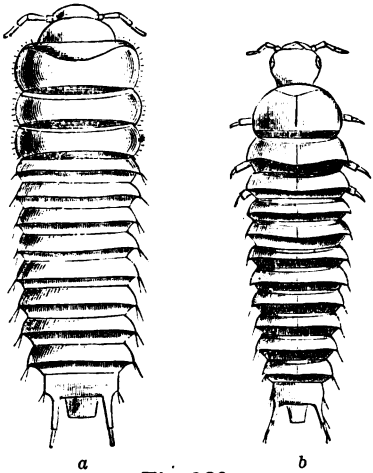
ordinarily feed upon plant lice. There sometimes come periods when aphids are not to be found in the necessary numbers—early in the season or sometimes late in the year—or where the season has been unfavorable for their development. In such cases the lady-birds will sometimes feed on pollen, or upon the spores of fungi, or upon some forms of fungi themselves, and one of the species, *Megilla maculata*, has even been observed feed-feeding upon the soft kernels of grain. These are exceptional instances, however, and only show that lady-birds do occasionally have bad habits like almost everybody else inhabiting this wicked world.

Fig. 129.

Egg masses of the boreal lady-bird. (Original.)

While there are no other families in this series of clavicornes that are as actively beneficial as those which I have already mentioned, there are others that are indirectly advantageous, and occasionally there are some that are positively helpful. Among these which are indirectly beneficial are the *Silphidæ*, or "carrion" or "burying-beetles." These insects feed both in the larval and adult stages upon dead animal matter, and they prefer in many cases small animals, in which they will lay their eggs and which they then undermine, throwing out the soil from beneath until the dead animal sinks a little distance beneath the surface, when it is covered up, and the larvæ of the beetles de-



a b

Fig. 130.

Silpha lapponica, larva: *a*, young; *b*, fully grown. Enlarged. (After Packard.)

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velop in this decaying matter. The larvæ are usually oval, flattened, quite often black in color, the segments well marked and resembling in some respects the so-called "sow-bugs." The insects

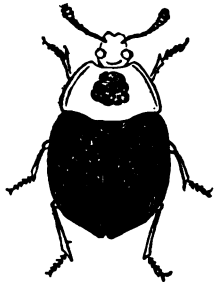

Fig. 131.

Silpha americana. (After Standard Nat. Hist.)

Fig. 132.

Necrophorus americana. (From a photograph)

are indirectly beneficial in so far as they remove carrion or assist in rendering it innoxious. The adults or beetles differ somewhat in form and are generally contrastingly black and red or yellow in color,

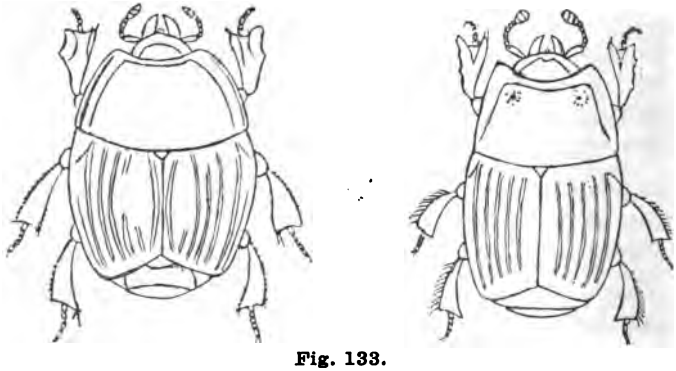

Fig. 133.

Hister arcuatus and *H. bimaculatus.* (After Standard Nat. Hist.)

with rather long, stout legs formed for digging, and with the club of the antennæ forming a little round ball at the tip, and by these characters the insects can be readily distinguished. Any small animal

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thrown outdoors and left there over night will be almost certain to attract anywhere from one to a dozen specimens of these beetles, where they can be easily observed.

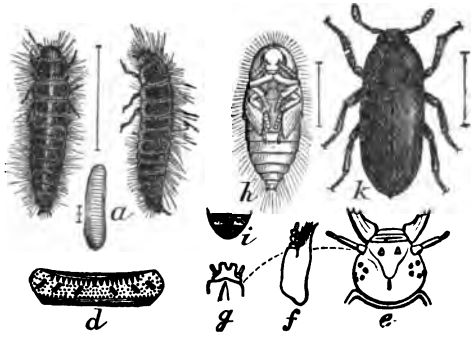

Fig. 134.

Leather-beetle, *Dermestes vulpinus*: *a*, egg; *b*, *c*, larva; *d*, *e*, *f*, *g*, details of larval structure; *h*, pupa; *k*, beetle. (From Rep. U. S. Dept. Agri.)

Another little family somewhat allied to the preceding in habits are the *Histeridæ*. These are more generally found in excrement, in decaying fungi or vegetable matter generally, though frequently also in decaying animal matter. They are small, rounded, sometimes almost

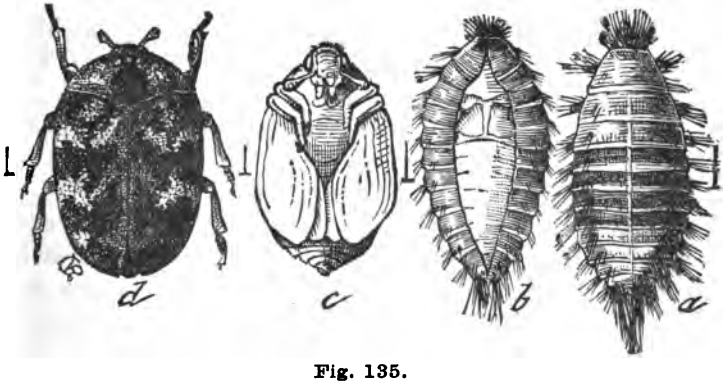

Fig. 135.

The carpet-beetle or "buffalo moth," *Anthrenus scrophulariæ*: *a*, larva; *b*, pupa enveloped in larval skin; *c*, same, removed from its envelope; *d*, beetle. (After Riley.)

spherical, shiny black, bronze or greenish creatures, of an exceedingly hard texture, also with the club of the antennæ forming a round knob at the tip. Their mission in life is much the same as that of the pre-

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vious family, though we have some forms that are predaceous in character; that is, they live upon other insects, more usually as larvæ.

Some of the families feed upon dried rather than decaying animal matter, and such are the *Dermestidæ*, which are usually small beetles, oval or sometimes rather elongate in form, with the head very much retracted, and a triangular thorax, the wing covers quite frequently clothed with scales. They are really injurious rather than beneficial, and good examples are the "bacon-beetles," the "carpet-beetle" or "buffalo moth," and the museum pests commonly known as anthrenus. The larvæ are stout, rather active grubs, densely clothed with long, bushy hair. Good representations of some common forms are given in Figures 134 and 135.

Other families prefer to feed in decaying fruits, or on the sweet sap of trees, or in fungi, and among these we need only mention the *Nitidulidæ*, which are usually more or less flattened insects, quite elongate, with the wing covers somewhat shortened and not covering

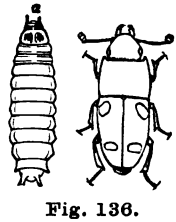

Fig. 136.

Ips fasciatus and larva. (After Packard.)

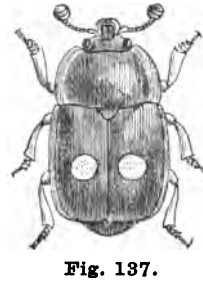

Fig. 137.

Nitidula bipustulata. (After Standard Nat. Hist.)

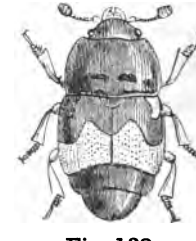

Fig. 138.

Carpophilus hemipterus. (Aft. Standard Nat. Hist.)

the entire abdomen. The head is more distinct, and the antennæ are also usually furnished with quite a prominent club. These insects rarely become troublesome, since only in exceptional cases do they attack sound fruit; although they make their appearance very rapidly where any of it has been bruised.

None of the other families belonging to this series need be specially mentioned, although there are many of them; some living in water, but most of them on land. They are, except, of course, the aquatic forms, essentially species that feed on exuding sap, upon fruit juices, on dead, dry or decaying animal and vegetable matter, and upon fungi, and very few of them are injurious to the farmer. Therefore

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beetles that have the antennæ terminated by a more or less obvious club, the other joints not being serrated, can, as a rule, be regarded as at least innoxious and sometimes beneficial. The injurious exceptions need not be pointed out here at present.

Another large series of the *Coleoptera* is that in which the tarsi are five-jointed on all legs, and the antennæ are slender and filiform or thread-like, with eleven joints in most cases; and all of these may be considered as beneficial. They are, as a rule, predaceous, both in the larval and adult stages, and though there are a few cases where the beetles will gnaw the seeds of grasses, yet there are no instances in the entire series, comprising of American species more than a thousand in number, where they are seriously injurious to field or farm crops.

The first of the families in this series is the *Cicindelidæ*, or "tiger-beetles." These are so named from their very active and predaceous habits, and perhaps somewhat also from their colors, which are occasionally bright-banded. The beetles live mostly in sandy spots or along roads, more rarely in meadows or in woods. They have long legs and run rapidly, and fly as readily as they run. They are cylindrical or nearly so, often somewhat flattened and more moderately elongate. The head is large, the eyes quite prominent, and the jaws or mandibles are long, very hard or chitinous, sickle-shaped, and with a fine, sharp-pointed tip. They prey on other insects of almost every

Fig. 139.
Cicindela 6-guttata.
(After Riley.)

Fig. 140.
Cicindela repanda.
(After Packard.)

Fig. 141.
Cicindela generosa.
(After Packard.)

Fig. 142.
Cicindela purpurea.
(After Packard.)

description, and are very voracious. Unfortunately, they rarely go into cultivated fields, and are therefore of less importance to the farmer than some others with similar habits. The larvæ are curious creatures, making burrows, usually in sandy soil, in which they rest

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with their head on a level with the surface, waiting for those unlucky creatures that may happen to come in their way. The figures herewith given illustrate both the larva and the beetles, so as to enable them to be recognized rather readily. We have quite a number of species in our State, the most common of which is perhaps *C. repanda*, which is gray in color, with the wing covers banded with yellowish white. This is found in sandy spots and roads, usually in company with a larger, more brightly-banded form, the *C. generosa*. Toward the seashore we have a similar form, but with the thorax clothed with long, fine, white hairs, and hence termed *hirticollis*, while on the shore itself *C. dorsalis* is white, with bronze markings. In the woods or in shaded lanes we find a bright-green form, with six white dots on the wing cover, *C. sexguttata*, while *C. purpurea* is obscure red-brown, with only an inconspicuous band on the wing covers, and it inhabits grassy lands.

Fig. 143.
Larva of cicindelid from side.

The second family belonging to this series is the *Carabidæ*, or ground-beetles. These contain a very large number of forms, usually living on the surface, hiding in the ground, under leaves, sticks or stones, or wherever else they can find shelter. They have the advantage of being able in many cases to live in cultivated fields, both as beetles and in the larva state. Among these are many insects that are extremely important to the farmer, living as they do upon soft-bodied larvæ that they find upon low plants, and that go into the ground. An enormous number of larvæ, like those of the plum curculio or the pear midge, are annually destroyed by insects of this family, and they are of very high importance to the farmer for this reason.

Coming very early in the series we have a number of large forms in which the head is quite prominent and free, the jaws well developed, sharp-pointed, the thorax more or less rounded at the sides, and the body much broader, flattened above. Some of these are from an inch to an inch and a half in length, and many of them are quite prettily colored, often metallic blue or green or bronze, sometimes black. The wing covers are rough and are often ridged and sculptured in various ways. Of these are the so-called "caterpillar hunters" classified in the genus *Calosoma*. These beetles are so called because of their habit of climbing trees and other plants and searching for

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caterpillars of various species that feed upon the leaves. It was my fortune to see in Cape May county some three years ago an invasion of spanworms, which were in immense numbers, principally upon

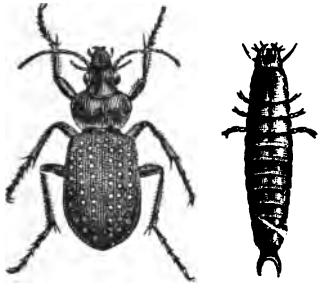

Fig. 144.

Calosoma calidum: the fiery ground-beetle and larva. (After Riley.)

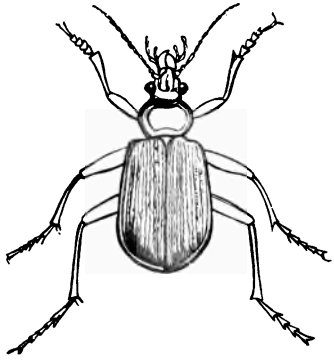

Fig. 145.

Calosoma scrutator. (After Riley.)

the scrub oaks found everywhere throughout that region. On almost every tree could be seen anywhere from one to three or more specimens of the largest of our species, *Calosoma scrutator*, which was preying upon the caterpillars, killing numbers of them, apparently for the mere pleasure of killing, only a small portion of each caterpillar being eaten. A picture of this species and of an allied one, called the "fiery ground-beetle," is given herewith in order to show the appearance of the insects belonging to this series. Species belonging to the genus *Carabus* resemble the preceding in general appearance, but the thorax is usually broader as compared with the wing covers, and the insects are somewhat more regularly oval. Most of them do not have the tree-climbing habit, and live under stones, boards, or in fact any shelter that they can find on the surface of the ground, or around the base of trees. They generally make their forays at night, and are rarely seen during the day, destroying, however, in the course of their lifetime a very large number of caterpillars, and particularly of cutworms, of which they seem to be especially fond. The larvæ of these insects are as rapacious as are the adults, and they do perhaps quite as much good. They live on or in the ground, sheltered under stones, or sticks, or other rubbish, or sometimes under mere clods of earth, and they also make their way out at night,

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feeding upon such soft-bodied insects as they can find. They are long, rather slender creatures, flattened above, with prominent jaws, and short antennæ or feelers, and often have horny points or forceps at the end of the last segment of the abdomen. This character of life is found, essentially, through the entire family, and, so far as I am aware, all of the larvæ are carnivorous, though a few exceptionally attack vegetable matter when their ordinary food is not abundant. Many of the larvæ have the advantage of being able to live in tilled fields, finding sufficient hiding-places in the loose soil or in crevices about the base of plants. They are peculiarly valuable to the farmer from their habit of attacking those insects that live in the soil or below it, or that go into soil to pass the pupa stage. The number of cutworms destroyed by larvæ belonging to this family is enormous, and in potato-fields a very large number of larvæ of the Colorado potato-beetle are captured and destroyed when they go into the ground to pupate. Unfortunately the better cultivated a field the less chance there is for the existence of these larvæ, and of the beetles themselves, in fact. Most of them require hiding-places of some kind, and unless these are convenient the insects of course leave the locality and fix themselves elsewhere. In this way the farmer is sometimes his own greatest enemy, because his method of managing his land is the one best calculated to increase the number of injurious and decrease the number of beneficial insects that find it possible to live in his fields. It is not only the large types which have been described that contain the most useful forms. We have a great many others, much smaller in size, belonging to other genera, notably *Bembidium*, of which a very great number find it possible to live in cultivated ground. These are small, usually quite depressed or flattened forms, rarely more than one-fourth of an inch in length, and very active, running rapidly over the surface of the ground, but rarely attempting to fly. These destroy an enormous number of small insects or the young of larger forms, and are of very great use to the farmer. They are frequently metallic in color, though more usually black or bluish, and sometimes marked with yellow or red on the wing covers. Larger species, some of which are also able to live in cultivated ground, are the species of *Pterostichus*, which average from one-half

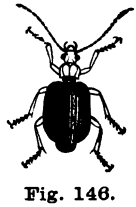

Fig. 146.
Lebia grandis.

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to three-fourths of an inch in length. In these the thorax is considerably broader, though usually narrower than the wing covers, and the species are almost, without exception, black, sometimes with a greenish or bronze-metallic luster. Others belonging to this family are more flattened than in *Pterostichus*. The thorax is quite small in proportion to the rest of the body, and the legs are considerably longer, and many of them belong to the genus *Platynus*, which, also, are able to live in cultivated fields. Near allies of this last genus are a series of others which are, if possible, even more flattened, and have the thorax very small compared with the very broad wing covers, which are usually squarely cut off behind and leave exposed a part of the abdomen. These belong to the genus *Lebia* and its allies, and are much more frequently found on plants than any of those heretofore mentioned; one of them, *L. grandis*, has been noticed on potato plants eating the eggs and young larvæ of the potato-beetle.

Fig. 147.

Harpalus caliginosus. (After Riley.)

Following these, we have a series of species in which the thorax is broader—as broad, or nearly so, as the elytra, or wing covers. They are more heavily built and less active than those heretofore mentioned. The head is smaller but massive, and the jaws are broader

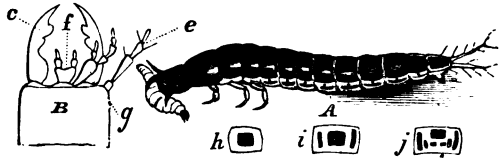

Fig. 148.

Larva of *Harpalus* feeding on a curculio larva. (After Riley.)

and apparently stronger. Among these, we find species which still are, in general habit, carnivorous, and yet have been observed, in some instances, feeding upon vegetation, particularly upon seeds of grasses, and even upon corn. None of them, so far as I am aware, have been considered as really injurious, and the benefits to be derived from them are far in excess of what little injury they may cause by feeding upon seeds or occasionally on pollen. Figures illustrating

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all the types that have been mentioned will be found scattered through the text, and will aid the farmer in recognizing the appearance of the beetles of this family that may be considered friendly to him. I may repeat, that all insects in which the tarsi, or feet, are five-jointed, and the antennæ are filiform and thread-like, usually eleven-jointed, may be considered as beneficial, or at least harmless insects, and they should, under no circumstances, be disturbed. There are several other families belonging to this same series with five-jointed tarsi, and they are all more or less predaceous species; but all of them live in the water, and therefore have little or no interest for the farmer.

We have another large series of species comprising a considerable number of families, all of which are distinguished by having the tarsi of the first and second pair of legs five-jointed, while the tarsi of the posterior pair are four-jointed, whence they are called *Heteromera*. There is quite a little tendency among the forms belonging to this series to have the joints of the antennæ more or less bead-like, or as it is termed by entomologists, moniliform, especially towards the tip, where it is not infrequently somewhat enlarged. A large proportion of all the species belonging to this series live on dead vegetable matter, frequently under bark of trees, often in decaying wood, sometimes in fungi either fresh or dried, occasionally in stored products, and rather rarely upon living vegetation.

The most interesting family belonging to this series is the *Meloidæ*, or as they are commonly termed, the blister-beetles. These insects have been used in Oriental medicine as early as history gives any account of the mode of treating diseases, but however curious medical properties they have, they are to the naturalist still more curious on account of their remarkable life history and the strange modifications which parasitism has produced in the larval forms of many of them. The beetles themselves are generally of medium or large size; the vertical head is abruptly narrowed behind into a neck, the thorax is more or less cylindrical, usually narrower than the head, and almost always narrower than the wing covers, which are usually of a rather soft texture, and are not highly chitinized. The insects that furnish the cantharidin which is used for blistering in medicine are found in Europe, principally in the Mediterranean country, but most if not all of our own species possess this property in a more or less marked degree. Some of the species, therefore, have a distinct economic value

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in themselves, but, as has been already indicated, the species are at least in part parasitic, and therefore are of interest also to the farmer. But they are injurious as well as useful, and at least two, if not three, of the species occurring in our State are sometimes destructive in potato fields, where they are known as the "striped potato-bugs" or the "black potato-beetles," or sometimes as the "old-fashoned potato-bugs," the story being that in times past insects of this character were much more common than they are at present, when the Colorado beetle monopolizes most of the attention of the farmer in the potato-field. Yet even the beetles that eat the potato leaves are occasionally useful, because they have been noticed in some instances feeding upon the larvæ of the Colorado beetle. If this habit of feeding on potatoes was the only one to be considered, we need not hesitate long about deciding whether the insects were or were not injurious;

Fig. 149.

The "Spanish fly," *Lytta vesicatoria.*

but unfortunately, if we take the larval history of the insects into consideration, the matter is by no means so clear. In the larval state the blister-beetles are either parasites upon bees or they live in and feed upon the egg-pods of various species of grasshoppers. The development from the egg to the imago in this family is much more complicated than in any other family of beetles, and has been termed a hypermetamorphosis. In brief, it is as follows: The egg is laid on the ground, or sometimes on plants which are frequented by the adults, and from it hatches a larva called a triungulin, which is a very active creature with six legs and a rather slender body. These triungulins or first larvæ run rapidly about, some of them ascending plants, while others live on the ground, their mode of life varying according to what their subsequent history will be. Those forms that ascend plants are usually parasitic upon bees of various

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descriptions, and the young larvæ remain about flowers until they have an opportunity of fastening themselves to some bee that is busy in obtaining honey or pollen. Attached to its body, they allow themselves to be carried to the nests, where their further transformations are undergone. If they get into the proper location, that is, among the cells of the bees, the little larvæ make their way into a cell and first devour the egg or young larva of the bee that was intended to occupy it. Thereafter they feed upon the pollen and honey that has been stored up for the larva which they have devoured, and there

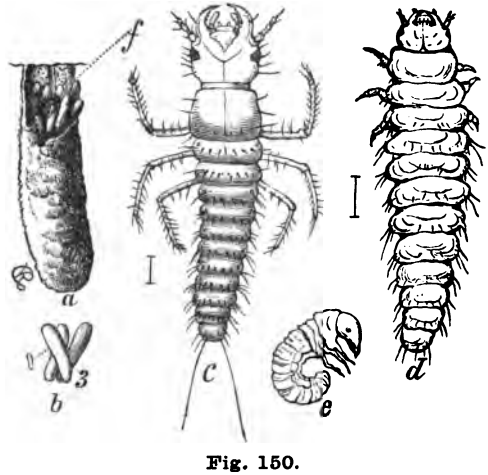

Fig. 150.

Epicauta vittata: *a*, egg-pod of *Caloptenus differentialis* with the mouth torn open, exposing the newly-hatched larva of *Epicauta* eating into an egg; *b*, egg; *c*, first larva or triungulin (greatly enlarged); *d*, caraboid stage of second larva, dorsal view (greatly enlarged). (After Riley.)

they undergo their transformations. These, while they are of extreme interest, need not concern us at present, because bee-parasites, even though of wild bees only, can scarcely be termed beneficial insects from the farmer's standpoint. Others of these triungulins do not ascend plants, but remain on the ground wandering about, able to sustain themselves without food for quite a long period of time, until they find an egg-pod of some species of grasshopper. When they have found this, they enter it, begin feeding and almost immediately moult and cast their skins. The creature that then appears is quite unlike the active form that has hatched from the egg and resembles very much more nearly the larva of the *Carabidæ*, whence Dr. Riley, who has written the life histories of several of our species,

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has termed it the carabidoid stage. Another moult or changing of the skin transforms it into a still more clumsy, fleshy larva, which is very sluggish indeed, and resembles in some respects the white grubs, whence it has been called the scarabidoid stage. All this time the insect is feeding upon the eggs in the grasshopper pod, and undergoes yet another moult, which produces the ultimate stage of this second larva. It is now full fed, and for the first time leaves the egg mass in which it has heretofore lived, forms a cavity in the ground, partially moults, and enters what is called the pseudo-pupal stage, in which it is inactive and remains enveloped in the skin which has not been entirely shed. In this stage it usually hibernates or passes the winter, and in spring it rids itself of this old skin, and appears in yet another form, which is called the third larval form. This third larva

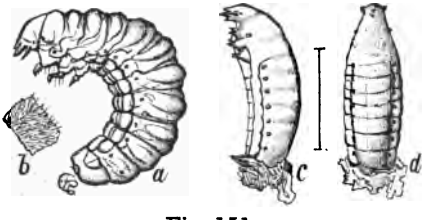

Fig. 151.

Epicauta vittata: *a*, full-grown stage of second larva; *b*, portion of the dorsal skin of same; *c*, pseudo-pupa, or coarctate larva, lateral view; *d*, same, dorsal view. (After Riley.)

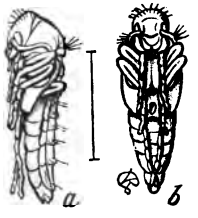

Fig. 152.

Epicauta vittata: *a*, true pupa, side view; *b*, same, ventral view. (After Riley.)

burrows about in the ground without feeding, in due time forms a normal pupa and soon thereafter the imago or adult beetle emerges. This egg-feeding habit of the blister-beetle larvæ is an extremely important one, and there is no doubt whatever that some of the grasshoppers in this State are kept down to a very great extent by the insects of this family. In the year 1892 grasshoppers, through climatic causes, became exceedingly abundant, and were very injurious in many parts of the State. As a matter of course, eggs were deposited everywhere, and probably the great majority of all the triungulins of every proper species of *Meloid* succeeded in finding pods in which to undergo their transformations. In this way the supply of grasshoppers for 1893 was undoubtedly much lessened, but at the same time the number of blister-beetles was correspondingly increased, and when they emerged they at once began feeding upon

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their favorite plants. We have here a rather nice question which has been once before stated: Are these insects more beneficial than injurious, or more injurious than beneficial?—is the damage that they cause by feeding upon potato vines greater than the benefit derived from the destruction of grasshopper eggs or is the contrary true? This question will not be decided in the same way by farmers generally, and a local reason will usually turn the scale in one direction or the other. Personally, I think that the insects are very much more beneficial than they are injurious, for their injury can be checked in most cases without any very great difficulty, if poisons are applied in time, and at the worst the insects remain only for a very short period and rarely do damage which is not readily made good by the plant after they leave. We must consider each blister-beetle to be the representative of all the grasshoppers that would otherwise have issued

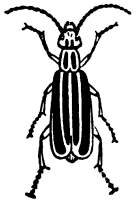

Fig. 153. *Epicauta vittata*, imago. (After Riley.)

Fig. 154. *Epicauta cinerea.* (After Riley.)

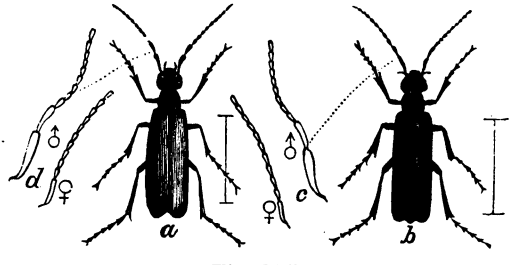

Fig. 155. *a, Macrobasis unicolor; b, Epicauta pennsylvanica.* (After Riley.)

from the egg-pod in which it passes its early stage, and it is scarcely questionable which would have done the most damage, a single beetle feeding for a week at the outside, or fifty grasshoppers feeding for six weeks or more. The sudden re-appearance of these blister-beetles in great numbers in 1893 is thus readily accounted for, and we need have no apprehension that next season will see an increase. We will more probably see a decided decrease, since grasshoppers were much less abundant in 1893 than in 1892. In our State there are three species that have been either proved to be parasitic upon the eggs of grasshoppers, or which are, probably with justice, suspected of being so parasitic, and these will be briefly mentioned here.

Perhaps the most common of these is the "striped potato-beetle," *Epicauta vittata.* This is a dull-yellowish insect with black stripes,

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and it makes its appearance about midsummer, or a little earlier. Somewhat less abundant is the "black potato-beetle," *Epicauta cinerea*. This is a somewhat larger, more robust species, black in color, the thorax marked with a central, pale ashen-gray streak, and the wing covers edged at the sides and where they join with a narrower streak of the same ash-gray color. It frequently occurs with the preceding, and the two may make their appearance in the potato-field at the same time. From the peculiar life habits of the species, it will be seen that they become full grown and enter the pupa state at about the same time, and that the same weather conditions which favor the maturing of one specimen favor also the maturing of all. Therefore instead of the insects making their appearance gradually, the entire brood seems to issue at once. Appearing thus in enormous swarms at one time, they frequently do considerable damage before the farmer realizes that there is any trouble brewing. The third species to which reference was made is the *Epicauta pennsylvanica*. This is smaller than either of the others, seldom infests potatoes, and is easily recognized by being entirely black in color. It usually makes its appearance somewhat later in the season, and is often found in very great numbers on the golden-rods. Appearing suddenly as they do, the insects disappear nearly as suddenly and completely. They may be about a field a week or ten days, and then disappear and leave no trace. Some other, rare species, occur occasionally in our State, and these may be sometimes observed in considerable numbers on one day only, disappearing absolutely a day or two afterward, not to re-appear until the following season. As a whole, I think we may consider that the blister-beetles are more beneficial than otherwise; but where they appear in troublesome numbers in potato-fields, I would not advise the farmers to hesitate about destroying them. The best method for doing that is to gather them in pans early in the morning before they fly readily. The pans should have a little water with a scum of kerosene floating on it, and this will kill or disable the insects as soon as they are immersed in it. Another method which is often successful, is to drive the insects. During midday they are easily disturbed and fly readily, and they can be driven from a field with comparative ease. Frequently a layer of straw is spread on one side of the field and into this the beetles are slowly driven, the straw being then set on fire and the beetles burned.

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None of the other families belonging to this series of *Heteromera*, so far as they occur in our State, can be considered as beneficial. We have a number of families represented, but comparatively only a few species occur with us. It is in the high Western plains, on the Rocky mountains and in their valleys, and along the Pacific coast, that we find these families at their best, and there are many points where the species belonging to this type constitute the great majority of the fauna, not only in number of species, but in number of specimens as well. A type of the family *Tenebrionidæ*, which is the largest, or that containing the greatest number of species in this series, we can find in the common "meal-worm," which is familiar to most farmers. The larva is quite usual in grain bins or neglected meal bags in stables, and in fact wherever flour, meal, bran or even grain is carelessly left for a long time. The larva is an inch or more in length, rather slender, cylindrical, somewhat flattened, with a yellow head, six small legs, and a hard terminal segment, ending in two small brown points. When it is full grown the larva changes to a pupa in the places where it has been feeding, and out of it comes a black beetle nearly three-fourths of an inch in length, which is oblong, the sides almost parallel, and is considerably flattened. Many of the members of this family can be found under the bark of trees, and some of them in decaying wood, where the larvæ probably find their subsistence. Other forms are more partial to tree fungi, and the same habits are found represented in the majority of other families belonging to this series. So far as I am able to remember, very few of the species belonging to this series of *Heteromera*, so far as they occur in our State, can be considered as seriously injurious, and on the other hand, with the exception of the blister-beetles, none of them can be considered as beneficial.

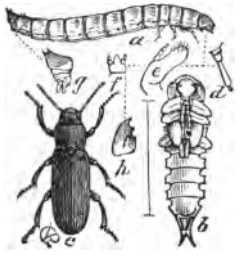

Fig. 156.

Tenebrio obscurus, the meal-worm: *a*, larva; *b*, pupa; *c*, beetle. (After Riley.)

The last order of insects of which mention will be made, and in some respects very much the highest in point of development, is the *Hymenoptera*. This includes bees, wasps, ants, saw-flies, gall-flies, ichneumon-flies and others of similar character. We have an enormous number of species belonging to this order, perhaps more than in

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any other, and we have only an extremely imperfect knowledge of those existing in our country. In this entire order there are very few that are really injurious, and on the other hand we have an enormous number that are of the highest value to the farmer. The *Hymenoptera* are mandibulate; that is to say, they are furnished with a pair of stout jaws or mandibles, and are thus able to chew their food. A considerable number of the species, however, are furnished with a long, tongue-like organ, which enables them to gather honey from the nectaries of flowers, and others which, while the tongue is not elongate, have it extremely sensitive, and apparently bladder-like, suitable

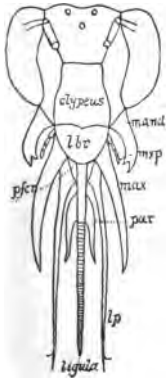

Fig. 157.

Head and mouth parts of bee; the tongue central. (After Newport)

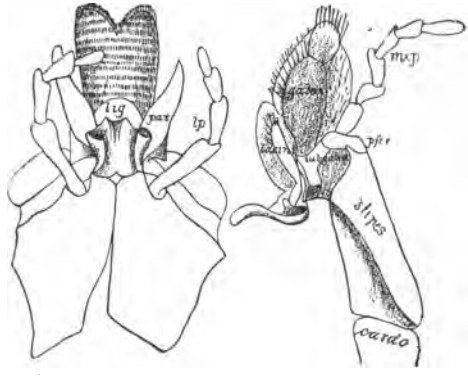

Fig. 158.

Mouth parts of a paper-making wasp, showing at *lig*, the bladder-like tongue. (Original.)

for lapping up liquids. These insects have four wings, except in isolated cases, and these wings are transparent, with a few longitudinal and transverse veins, forming only a small number of cells on the wing. As a rule the hind wings are very much smaller than the first pair. Sometimes, in the small forms, the venation may be entirely obsolete, or there may be only a small spur along on the costa or anterior margin.

There is one series, and only one, in this order, all the members of which are injurious and are plant-feeders. These are the *Phytophaga*, or leaf-eaters, and include the so-called saw-flies, the larvæ of which resemble caterpillars in general appearance, but differ from them obviously by having an extra pair of false legs. Many of them have

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also the habit of curling up the posterior part of the body when feeding, and quite a number of them seem to prefer feeding at the edge of the leaf, letting the hind body hang free. We have some troublesome insects among these saw-fly larvæ, and I need only instance among them the currant-worm, which is perhaps the most abundant and

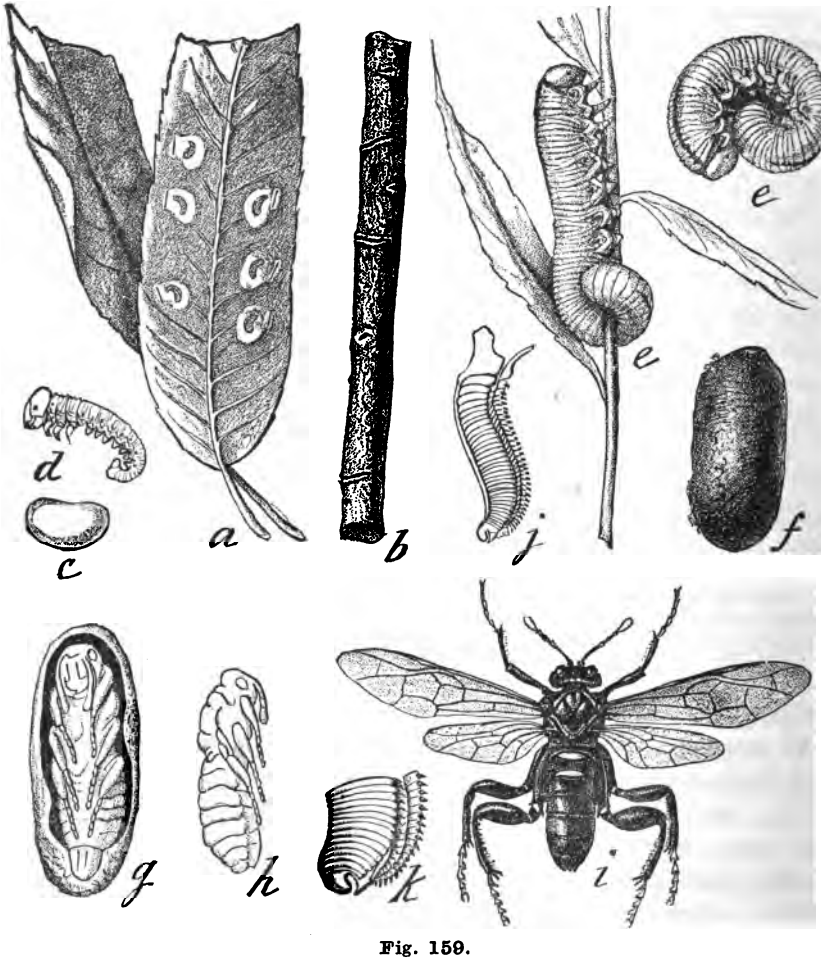

Fig. 159.

The large willow saw-fly, *Cimbex americana:* *a*, willow leaves showing egg-blisters from above and below; *b*, twig showing girdlings; *c*, egg; *d*, newly-hatched larva; *e*, *e*, full-grown larvæ; *f*, cocoon; *g*, cocoon cut open, with pupa; *h*, pupa, side view; *i*, male fly; *j*, saw of female detached, side view; *k*, tip of do.; *c*, *d*, *j*, *k*, enlarged, the rest natural size. (After Riley.)

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most generally distributed. The adult saw-flies can usually be distinguished from the other members of the order from the fact that the base of the abdomen is united by its full width with the thorax, whereas in most of the others the connection between the thorax and abdomen is reduced to a small stalk, sometimes so slender that it would seem as if the least touch would suffice to break the insect in halves. Insects like the saw-flies are said to have the abdomen sessile, while insects like wasps, which have an exceedingly narrow waist, are said to have the abdomen petiolate or stalked. The peculiarity from which the common term "saw-flies" is derived is found in the structure of the ovipositor or egg-laying tube in these insects. Instead of being a mere pointed sting, or a long or short tube, the ovipositor is formed of four distinct blades, which are toothed like a saw in the majority of cases, although some of the combined blades have a good deal more of an auger or gimlet shape. By means of these saws, slits or pockets are cut into the leaves or other tissue on which these insects feed, and the egg is laid in the cavity thus made. These saws make beautiful objects under the microscope, and the variety found is almost infinite; sometimes of the simplest possible construction, sometimes complicated in the most diverse ways. It is rather interesting to note that almost all the types of saws that are in use by mechanics, for almost all sorts of work, including ice-cutting, are already represented naturally in these insects. It might pay some mechanical genius to study these insect structures with the idea of seeing whether it would not be possible to learn something new in mechanics from them. The subject of saw-flies is of sufficient importance to require a special treatise, which would of course not be in place here.

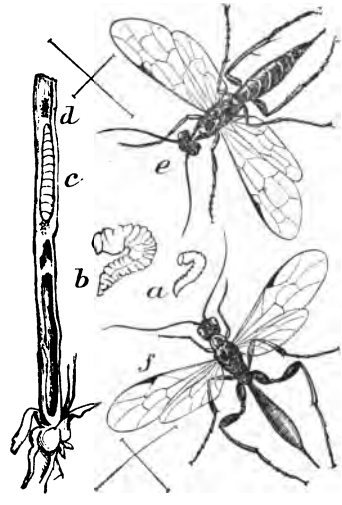

Fig. 160.

Cephus pygmæus, wheat-stem saw-fly: *a*, outline of larva, natural size; *b*, larva enlarged; *c*, larva in wheat stalk, natural size; *e*, adult female; *f*, female parasite, enlarged. (After Curtis)

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Nearly allied to the true saw-flies are others resembling them somewhat in general appearance, but usually larger and, in many cases, with a longer ovipositor, which extends beyond the end of the abdomen and is not concealed. These lay their eggs in the trunks of trees, or in herbaceous plants, and the larvæ are internal feeders, boring large holes and often causing great destruction, especially to pine timber. We have one very large species that is rather common, known as the pigeon-tremex, and of this a figure is given, and at the

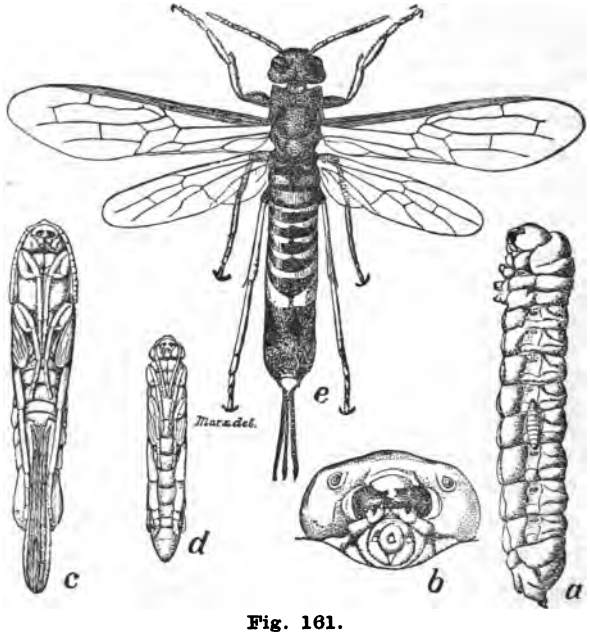

Fig. 161.

Tremex columba: a, larva, showing *Thalessa* larva attached to its side; *b*, head of larva, front view, enlarged; *c*, female pupa, ventral view; *d*, male pupa, ventral view; *e*, adult female. All slightly enlarged. (From "Insect Life.")

same time its parasite is also shown fastened to the larva; of this, I will again speak later on. Others bore in stems of wheat and grasses, and in the annual report for 1892, I described and figured a species boring in blackberry canes.

Following in the natural series those that have been just mentioned, we reach the immense series *Parasitica*. This comprises some of the largest families of the order, the members of which, in their larval state, excepting the gall-makers, are parasitic upon or

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within the bodies of other insects. Using the words of Westwood, "these are of vast importance in the economy of nature by preventing the too great increase of different species of insects, especially of the

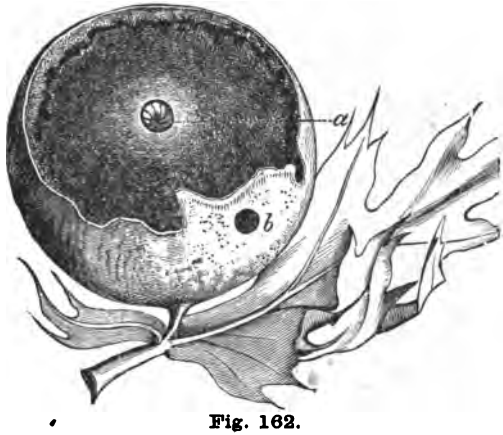

Fig. 162.

Gall made by *Cynips q. spongifica* on oak. (After Riley.)

caterpillars and moths, of which they destroy a great number." A very common character found in the parasitic forms is the presence of an exserted ovipositor; but this is not by any means a universal feature, and in very many cases it is short, concealed and occasionally formed like a sting.

The first of the families of the *Parasitica* is the *Cynipidæ*. The species of this interesting family are all small in size, the head is inconspicuous, the thorax usually robust, the abdomen generally oval and more or less compressed, sometimes even knife-shaped, and the ovipositor is spiral and concealed within two sheaths or plates. We have really two sections in this most interesting family in which the habits are distinctly diverse; but the characters separating the two sections are of such a nature as to be not easily recognizable,

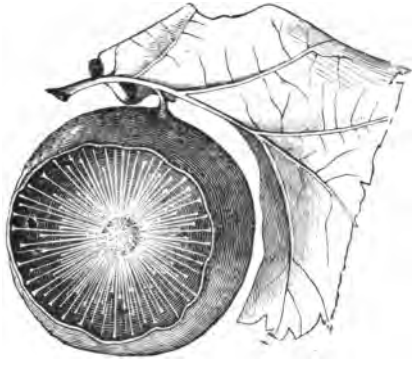

Fig. 163.

Gall made by *Cynips q. inana* on oak. (After Riley.)

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except by the special student. One of the sections contains, rather, plant parasites—that is to say, the larvæ do not feed upon the plant tissue as do most other insects; but they cause a swelling or excrescence, or a gall, and in the substance of this abnormal growth the insect lives. These galls are of the most diverse shapes, and the species is almost always recognizable by the gall it makes. Oaks are especially infested, and many species feed upon this tree. Sometimes cultivated plants are attacked, as, for instance, the blackberry; and roses occasionally suffer, but, practically, little real damage is done by them. The galls are not always upon the stems or leaves of the plants; but in some instances the roots are attacked and galls are formed underground. There are many interesting features in the life history of these species, which it would be out of place to call attention to here, and it must be left to the figures and what little I have said of a descriptive nature to give an idea of the appearance of the work of the insects.

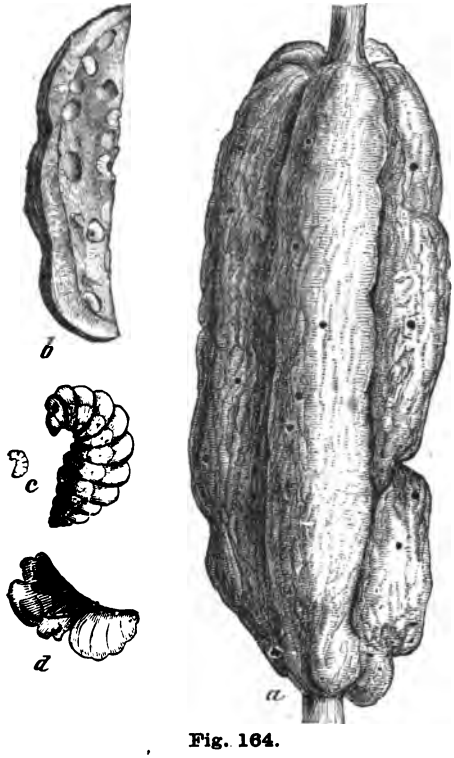

Fig. 164.

Pithy gall on blackberry made by *Diastrophus nebulosus: a*, gall from which insects have emerged: *b*, a section through, showing cells; *c*, larva; *d*, pupa. (After Riley.)

Two or three small families come in at this point which cannot be given a special reference here, and then we reach the great family *Ichneumonidæ*. This very extensive family is distinguished from the other parasites by having the wings with tolerably complete venation as a rule, a rather large, prominent head, with long, slender antennæ, which are never elbowed; a moderately large and well-developed thorax, rather long and slender legs, and a long, somewhat ovate or

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cylindrical abdomen, which, however, varies quite considerably. The ovipositor varies in length, but is quite often exserted or extended, and is attached before the apex or tip of the abdomen. Among the species of ichneumon we have many of our most common parasites, and those,

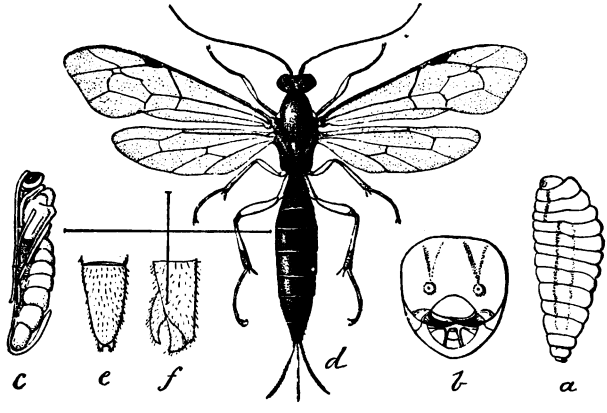

Fig. 165.

Pimpla conquisitor: *a*, larva; *b*, head of do., from front; *c*, pupa; *d*, adult female, hairline indicating natural size; *e*, end of male abdomen, from above; *f*, same from the side. All enlarged. (After Riley.)

too, that infest some of the most injurious of our caterpillars; for, after all, it is caterpillars that furnish a very large proportion of the food for these insects, and of the injurious types these parasites infest

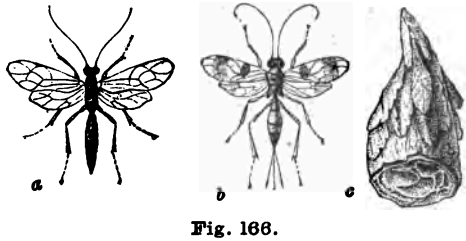

Fig. 166.

Hemiteles thyridopterigis: *a*, male; *b*, female; *c*, sack of bagworm cut open, showing cocoons of parasite. Natural size. (After Riley.)

the *Lepidoptera* most usually. A good illustration of the general form of the insects belonging to this family is shown in Figure 165. Quite a common type belongs to the genus *Trogus*, and is a red or yellowish form, with smoky-black wings. It is parasitic in the cater-

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pillar of our common black swallow-tail butterfly, which feeds upon carrots, parsley and the like. The larva of the parasite matures within the body of the caterpillar, which finishes its feeding as though in full health and changes to a chrysalis; but instead of a butterfly hatching from it an ugly hole is eaten into the side and this *Trogus* makes its appearance. Sometimes the species become very large, occasionally with the body transversely flattened almost like a knife blade, and these insects usually have a short, sting-like ovipositor; indeed they are able to use it in their own defense, and I have on more than one occasion proved their ability to penetrate the skin. The puncture, however, does not seem to be particularly venomous, and produces only a brief pain, which disappears without swelling. Some of these belong to the genus *Ophion*, and these are parasitic in the caterpillars of some of our large silk moths. Allied species also infest the yellow-necked apple-caterpillar, and do considerable good in keeping them within reasonable bounds. I have stated that in many cases the ovipositor was quite considerably extended beyond the end of the body, and sometimes this character is enormously exaggerated. This is especially true in the case of the species of *Thalessa*, which contains the largest of our ichneumon-flies, and here it is extended to a length of from three to four inches, and the insects have received the common name of "long-tails." They are frequently seen on tree trunks, and sometimes with the ovipositor inserted for its full length in the solid wood. I have not infrequently received specimens taken in that position, with the statement that they were injuring the trees and boring holes in them. Now as a matter of fact these insects are parasitic upon the larvæ of the *Tremex*, which was mentioned on a previous page, and these long stings or ovipositors are required in order to enable the insect to lay

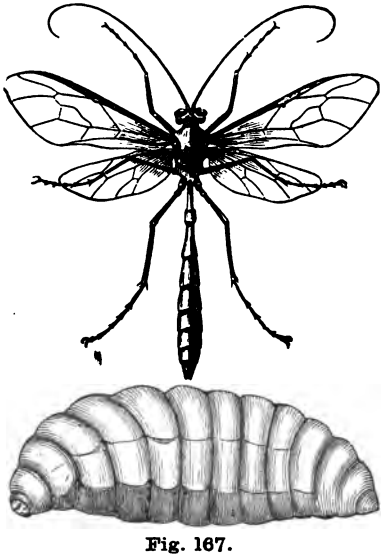

Fig. 167.
Long-tailed ophion, *Ophion macrurum*, and larva. (After Riley.)

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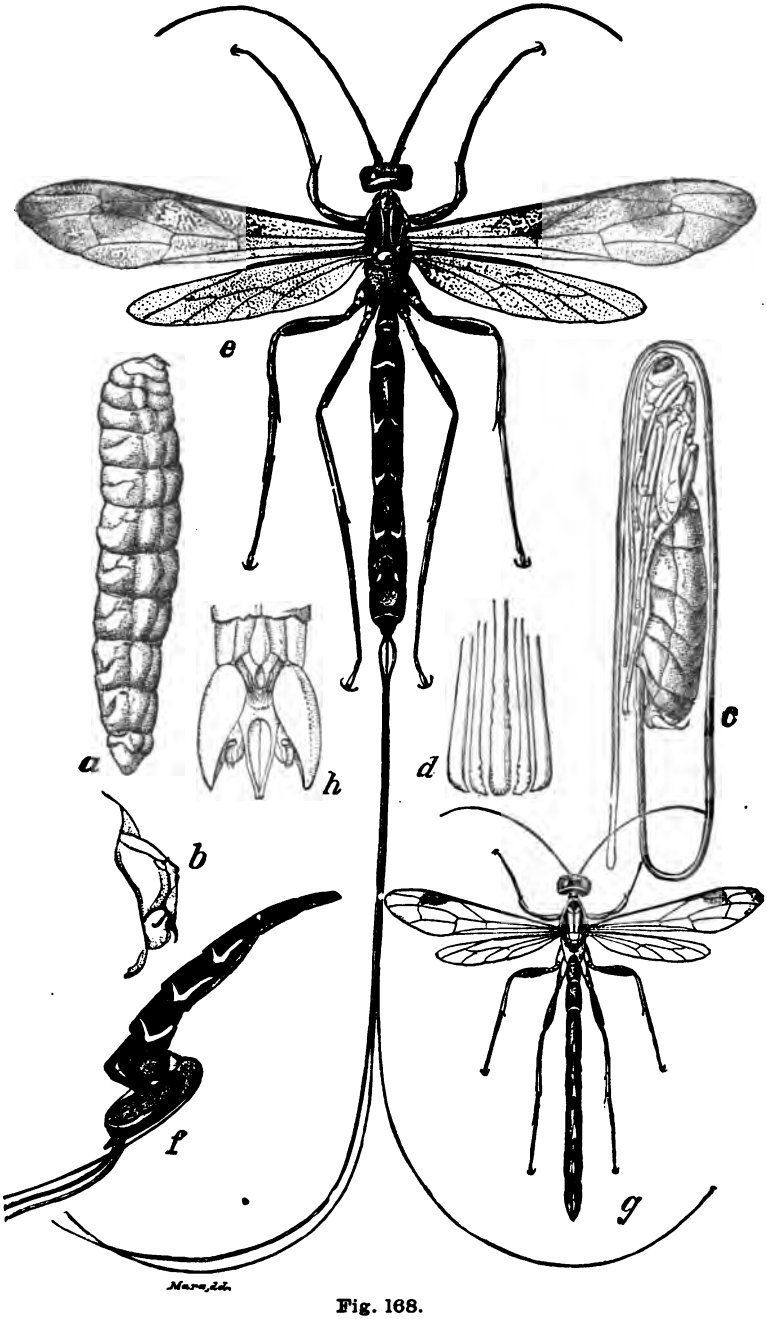

Fig. 168.

Thalessa lunator: *a*, larva; *b*, its head, from side; *c*, pupa; *d*, tips of ovipositor of pupa; *e*, adult female; *f*, abdomen from side; *g*, adult male; *h*, tip of abdomen of same. (From "Insect Life.")

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its eggs in the burrows of these borers. It is a most marvelous provision of nature for a very special purpose, and these insects seem to be enabled by some instinct to recognize the trees which are infested by their prey. With infinite labor and toil they force their ovipositor from two to four inches into the solid wood to get the opportunity of striking a burrow and laying an egg in it. The life history of this insect has been worked out by Dr. Riley, and the figures given, which illustrate this insect, were first used by him. We have many other genera and species that are of importance belonging to this same family, but it is naturally impossible to speak of them all here, and I can only endeavor to give a general idea of their appearance, showing their characters sufficiently to enable one to make at least a shrewd guess as to the probable relations of any insect observed.

The family *Braconidæ* is closely related to the preceding family, and is distinguished largely by the difference in the wing veins, which we need not trouble ourselves with trying to understand. There are a great number of species belonging here, and some of the forms are quite large, with more robust bodies than in the previous family. These sometimes have the abdomen contrastingly red, while the thorax and head may be black, and such forms are often members of the typical genus *Bracon*. Here, also, we find quite generally a more or less lengthily-extended ovipositor. We find, also, a very great number of small species; and those sometimes inhabit caterpillars in very great numbers. A well-marked instance is in the case of those which attack the tomato-sphinx larva. This will be sometimes noticed when it is full grown, or nearly so, covered with small, white, oval bodies like seeds or eggs, and indeed they are quite generally looked upon as eggs of the caterpillars and destroyed by farmers. As a matter of fact, however, they are the cocoons of the little parasites that have infested the caterpillar, and if the latter is watched when these larvæ first begin issuing from it, it will be noticed that from all parts of the skin little maggots begin poking their heads through little holes. They generally wriggle out until they are held only by the last segment, and then they begin spinning the little silken cocoons in which they change to a pupa. At this

Fig. 169.

Microgaster cocoons on sphinx larva. (After Riley.)

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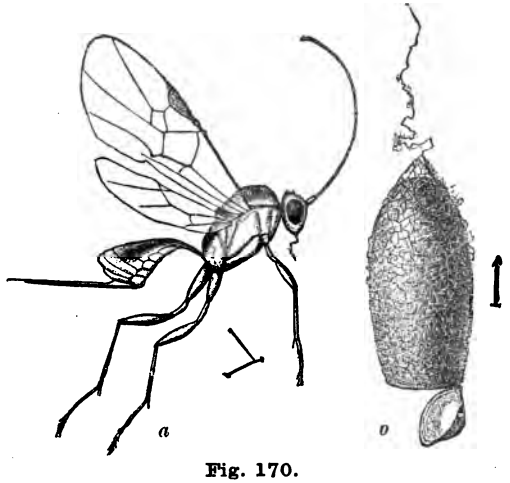

Fig. 170.

Meteorus hyphantriæ, parasite on fall webworm, and its cocoon. (After Riley)

time the caterpillar becomes flabby and dies, while in a very few days a little lid is separated from the top of the cocoons, and out of each comes a little wasp-like creature belonging to this

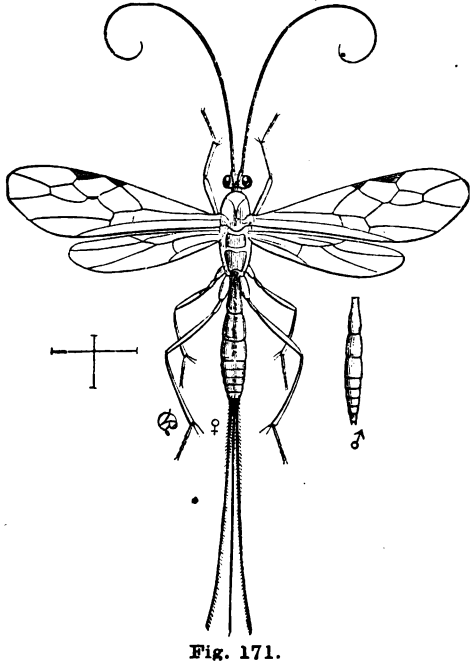

Fig. 171.

Macrocentrus delicatus, parasite on codling moth, cranberry-vine worm, etc. (After Riley.)

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family *Braconidæ*. These little egg-like bodies should never be disturbed, and under no circumstances destroyed. Each contains an active friend of the farmer, and were there enough of these, not a caterpillar of some species would succeed in coming to maturity. We have a very large number of species belonging to this type which spin little cocoons; but they do not always work their

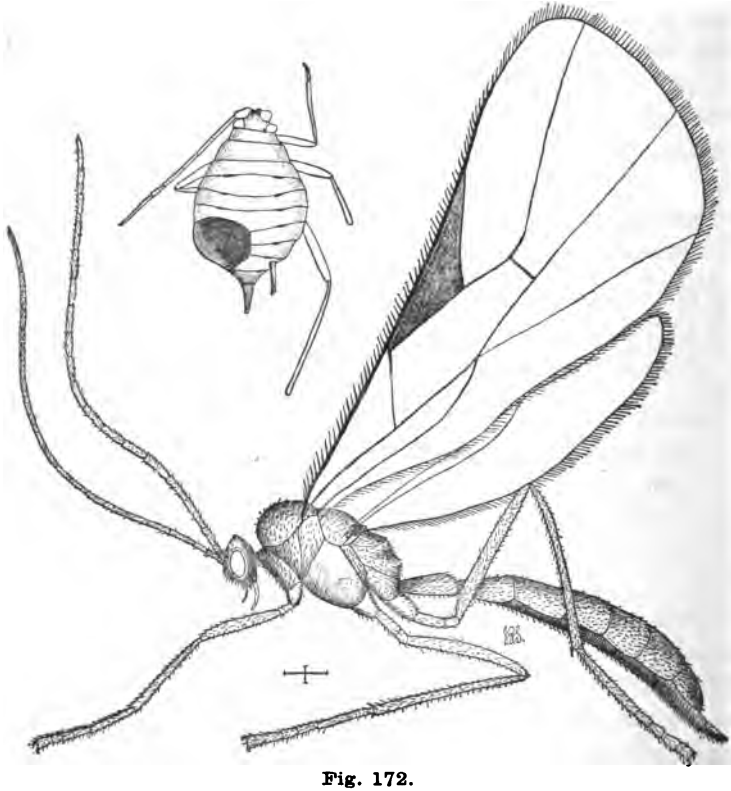

Fig. 172.

Aphidius granariaphis, showing above the parasitized louse from which it has issued. (Original.)

way through the skin, as has been described above. Sometimes the caterpillar will make a cocoon, and the parasites do not interfere with it until this is completed. Then, however, they destroy it, and in the cocoon made by the caterpillar there will be found, instead of a pupa, a mass of these little braconid cocoons. Not all of them, by any manner of means, make cocoons, and sometimes they change to a

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pupa within the body of a chrysalis permitting the caterpillar to complete its changes to that point. Not only caterpillars, however, are attacked by insects of this family, but insects of other orders as well, and a great many of the smaller species attack plant lice, a single plant louse furnishing food enough for the development of the larva of one of these little parasitic wasps. We have a number of species which are thus extremely useful, as, for instance, those which infest the melon and wheat aphids. I have seen them so abundant in one instance when the melon lice threatened injury that I was able to assure the grower that he need have no further fears, that injury

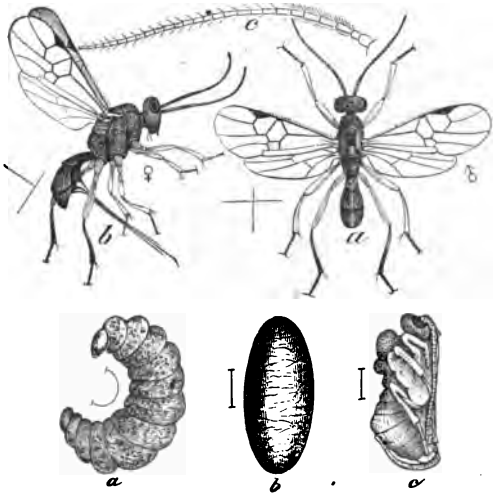

Fig. 173.

Sigalphus curculionis, parasite on plum curculio: larva, cocoon, pupa, and male and female imago. (After Riley.)

was checked for the season, and my prediction proved correct. One of these species was figured and described in Bulletin No. 72 of the Station as infesting the wheat louse, and this is extremely important in our State. Infested plant lice lose their green color, take on a bloated look and become a livid gray. In a very short time the insect within it matures, and through a little round hole, usually near the posterior end of the plant louse, it crawls into daylight, and almost immediately begins its work of laying eggs into other aphids.

Next follows the family *Chalcididæ*. This family is composed of

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a large number of insects, generally of exceedingly small size, many of the species having pretty metallic colors. The anterior wings are almost without veins, except along the front edge. The antennæ are exceedingly variable in form in this family, are often curiously developed in the males, and are quite usually elbowed. Their habits are parasitic in most cases. Many of them are parasites upon plant lice. A large number live in the eggs of other insects, the parasite being so minute that it finds a sufficient amount of nourishment in a single butterfly egg! Many of them, again, are parasitic upon other parasites—that is to say, they will lay their eggs, not in an injurious

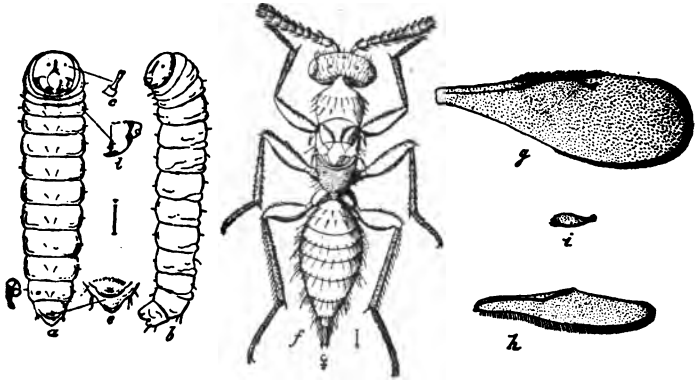

Fig. 174.

Isosoma tritici: *a*, *b*, larva; *f*, adult female; *g*, fore wing; *h*, hind wing. (After Riley.)

species, but in one of the parasites infesting it, and thus their parasitic habit might in some cases render them rather injurious than beneficial. It oddly goes to prove the truth of Dean Swift's famous couplet:

"The little fleas that do us tease
Have other fleas that bite 'em,
And those in turn have other fleas,
And so on *ad infinitum*."

We have, belonging to this family, some forms that are aberrant in their habits, departing from the usual type of development, and living in plants and feeding upon them. Such are the species of the genus *Isosoma*, which live in the stems of wheat, rye and other grasses, somewhat in the same manner in which the Hessian fly infests them, and causing occasionally quite marked injury. None of

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these forms seem to be troublesome in our own State, or at least I have never had them brought to my attention; but in the Western States, where wheat forms the staple, they sometimes cause appreciable damage. Many of the forms deposit their eggs in various galls, and the larvæ feed upon and destroy the legitimate inhabitants. Sometimes dozens of galls may be collected, and hundreds of specimens may be bred from them, and not a single specimen may be obtained of the species to which the gall is really due. So far as New Jersey is concerned, this family can be considered as equally beneficial with any of the preceding, and particularly from the plant-louse infesting habits of many of the species. A great many members of this family infest also micro-*Lepidoptera*, and the Angoumois grain moth, among others, is often badly infested. A very large number have been described, but it is probable that not one-tenth part of the actual number of species has yet been studied.

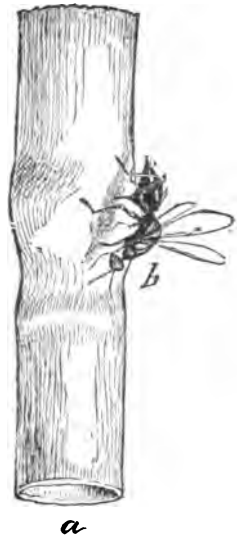

Fig. 175.

Isosoma ovipositing in stem of wheat. (After Riley)

Following the *Chalcididæ*, we have the family *Proctotrypidæ*, many of which resemble the former family; but are always distinguishable by the fact that the ovipositor is attached at the end of the abdomen, while in the others it is always attached at some distance before

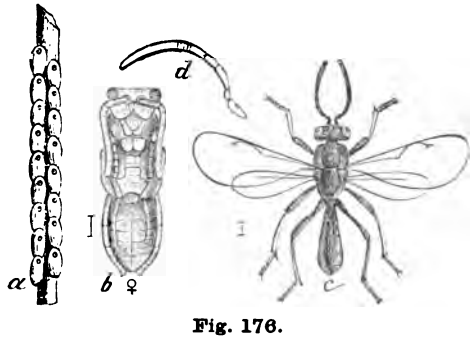

Fig. 176.

Eupelmus mirabilis, katydid-egg parasite: *a*, eggs from which parasite has emerged; *b*, its pupa; *c*, mature insect. (After Riley.)

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the end. This is a character that is easily seen by the student; but is of very little importance practically to the farmer, who is more especially interested in knowing the fact that the members of this

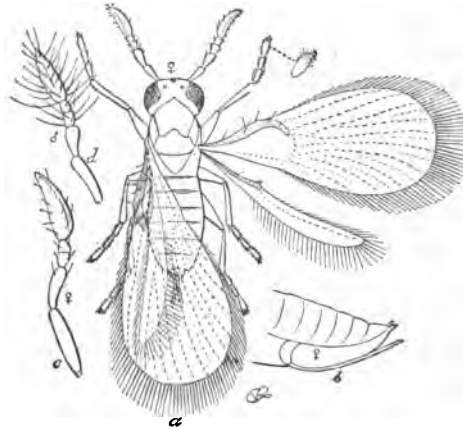

Fig. 177.

An egg parasite, *Trichogramma pretiosa.* (Greatly enlarged.) (After Riley.)

family, which are generally small and are usually shiny, black or brown in color, are equally valuable to him from the economic standpoint, and that all of them are parasitic. We have a very large

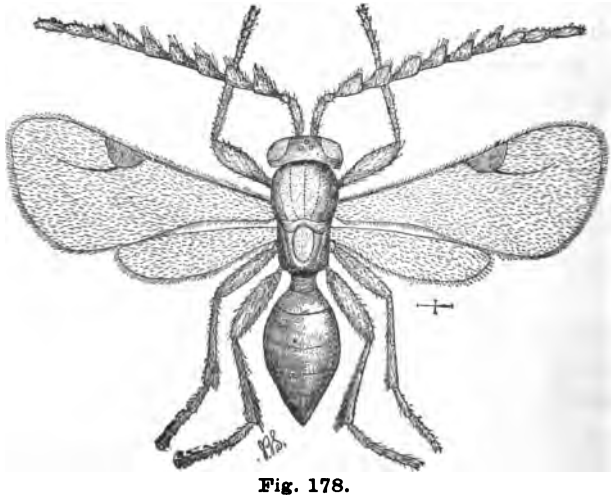

Fig. 178.

Ceraphron triticum, wheat-louse parasite (Enlarged.) (Original.)

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number of species which have just been monographed by Mr. W. H. Ashmead, who has shown that they are parasitic upon several orders of insects, and among others upon a large number that are injurious to the farmer. Among these also we have a great many that are parasitic upon plant lice, and in their general form and appearance they resemble the species of the other parasitic families. A figure of *Ceraphron triticum*, which also is parasitic on the wheat louse, is added to show the form of some of the species.

A most remarkable family is the *Pelecinidæ*, and specimens of the only species belonging to the family are not rarely met with. It is black, nearly two inches in length and very slender; remarkable for the very great length of the jointed abdomen, giving the insect a

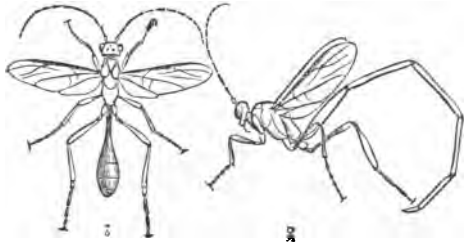

Fig. 179.

Pelecinus polyturator, male and female. (After Packard.)

characteristic appearance that is not to be mistaken. This structure, however, is found in the female only, and the male is rarely seen, having the appearance of a wasp. We have no certain knowledge as to the habits of this insect, large as it is; but it is supposed to be parasitic.

We are now at the end of the truly parasitic families whose mission in nature seems to be to check and keep within due bounds insects of many different kinds, and they themselves are kept in check by others that prey upon them, and by climatic and other factors. We may have some years a very great abundance of parasites, so it will be difficult to find caterpillars that are not infested, and it would seem as if, under ordinary circumstances, in the year following, freedom from insect pests would be assured; yet in some mysterious way during the winter the balance will seem to be changed and the following season may bring forth a great lot of caterpillars and few or no parasites; or a series of years may occur in which parasites are

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abundant, followed by another series of years in which they seem to be rare.

We have an odd little family called the *Chrysididæ*, or "cuckoo-bees," which in a sense are parasitic, because they build no nests of their own and store up no food-supply but watch their opportunity to lay their eggs in the nests of other bees and wasps, usually of the solitary forms. These eggs batch sooner than those of the legitimate inhabitant of the cell, giving the intruder a chance to feed upon the food stored by the maker and come to maturity, leaving the wasp or bee larva to starve to death. The insects are very easily recognized, the abdomen being made up of apparently a very few segments and the remainder modified into a telescopic and retractile tube, which is drawn within the body when not required. The species, though of moderate size, are among the most beautiful of our *Hymenoptera*, being adorned with brilliantly-metallic blue, green and ruby. The body is often deeply punctured, and the abdomen is frequently terminated by a series of more or less well-marked teeth. The insects are of no economic importance and we need not further consider them.

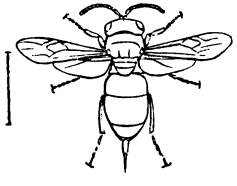

Fig. 180.

A cuckoo-bee, *Chrysis hilaris*. (After Packard.)

We now reach the ants, of which there are a number of families, but which for our purpose may be considered together, although they differ considerably in their habits, and in many cases even more in their life history. I need scarcely attempt to describe the ants, for every farmer has seen them of all sizes and of all colors, not only in fields, but frequently in houses, while they are common in woods, and especially in logs and stumps in a certain stage of decay. Some of the species in our State make quite considerable mounds. They are sometimes nearly three feet in diameter, although they rarely exceed from six to eight inches in height. There is a great deal of misinformation concerning these insects and their habits, and they are often looked upon by farmers as injurious; although, on the other hand, many seem to consider them as beneficial, claiming that they always see them where they see plant lice, and concluding, therefore, that they feed upon the lice. As a matter of fact neither conclusion is justified. The life history of the ants is a curious one, and they have an extremely complex social organization in many cases. In a

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general way an ant-hill contains, first, the mother or true female, whose sole business it is, as in the case of the queen bee, to lay the eggs by which the population of the colony is kept up, and this mother ant is generally of a very much larger size than the other inhabitants of the nest. We may have one or several males living in the nest as partners to the queen, but the bulk of the population is made up of workers, or neuters, as they are generally called. As a matter of fact, the workers, as is the case among the bees, are really undeveloped females, in which the growth of the ovaries and other organs of reproduction has been checked. These do all the work of the colony, and look after the eggs and young larvæ that are hatched from them. The larvæ are stout, fleshy grubs, without traceable legs, and are absolutely incapable of helping themselves. They must be carried from place to place as may be necessary, and they must be fed day by day, and are absolutely dependent upon their nurses, the workers. The queen concerns herself only in laying eggs. When these larvæ are full grown they spin little, oval, silken cocoons, which the ants very frequently transport to the outside of the nest to get the benefit of the warmth of the sun, and if an ant-heap is disturbed, one will frequently see the ants running about, anxious first to secure these cocoons and carry them down underground into their galleries. Very often these cocoons are looked upon as the eggs of the ants. From them in due time hatch the adults, which may be workers, or males, or females. If they are workers they are not provided with wings; but both males and females are so provided. The males and females do no work; but remain in the nest until spring, when on some bright, warm day all of them will agree to leave the nest, and a swarming takes place. Thousands upon thousands of these flying ants, or "pismires," as they are frequently termed, will be seen at one time, and this is their marriage flight. After the females are impregnated they alight on the ground and seek a place to build a nest. As wings are useless to them under the new conditions they strip them off, and they never grow again. The food of ants is decidedly various, and in some cases consists of vegetable matter, largely the seeds of grasses and grain which the insects gather and store. Sometimes, as in the case of the harvesting ants in the southern and southwestern parts of our territory, they may become decidedly injurious; but we do not have in our State any ants that infest cultivated crops in such a way

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that they can be considered as troublesome. Most of the species will feed upon animal matter, and undoubtedly many small insects are captured and destroyed, while any dead or dying specimen is seized almost immediately and carted off. In so far as they are predaceous they may be considered as beneficial, although they make no sort of distinction as to the character of the insects upon which they feed, and they will attack any beneficial insect just as readily as they will another. They are hardly of any advantage to the farmer from his standpoint. The relation of ants to plant lice is interesting, and is of

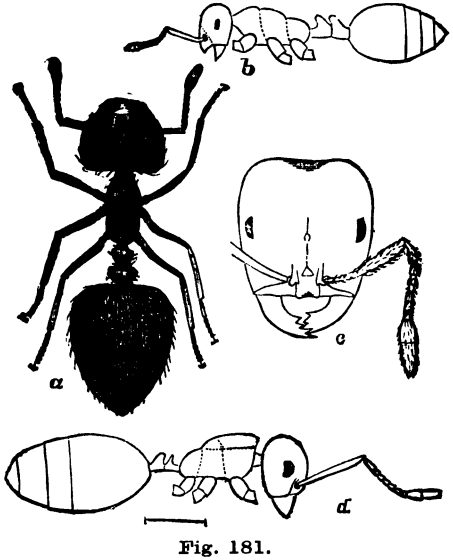

Fig. 181.

Solenopsis xyloni: *a*, worker-ant; *b*, same from side; *c*, its head; *d*, queen, from side. (After McCook.)

considerable importance. Plant lice, as is well known, excrete a sweetish liquid which is known as honey-dew, and of this liquid the ants are exceedingly fond. It is quite true that ants are usually abundant wherever plant lice are found, but they by no means injure the plant lice, but rather protect them, and the only business of the ants among the plant lice is to obtain the honey-dew, which the lice yield up to them readily when they are stroked by the antennæ or feelers of the ants. Some species are not satisfied with obtaining their supply of honey-dew in a haphazard way, but actually cultivate plant lice, usually of the varieties that feed on the roots of plants. On

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turning over large stones at the foot of trees we quite often find that all the roots that run under the stones have had galleries excavated around them by the ants, and on these cleared roots thousands of the aphids feed, crowded together as closely as it is possible for them to be packed. Very often ants gather and store in their galleries the eggs of certain species of plant lice, keep them safe during the winter, and in the spring colonize them on the roots of such plants as they can feed upon. Eggs, which the entomologist has never succeeded in finding, are gathered by the thousands, and it is probable that some species of plant lice depend entirely upon ants to enable them to live during the winter. In one instance at least this may assume an economic importance, and that is in the case of the corn-root plant louse, which is tended by a species of ant and depends largely, if not entirely, upon it. In this view ants can be considered as distinctly injurious, although indirectly so, because, while they do not themselves injure the crop, yet they look after and preserve the plant lice, which are sometimes exceedingly destructive. It is a very grave question whether the insects that they destroy will overbalance the harm that is done by their nursing others. Ants, therefore, can scarcely be classed as beneficial insects, although in our State they are not injurious in the sense that would require active measures for their destruction.

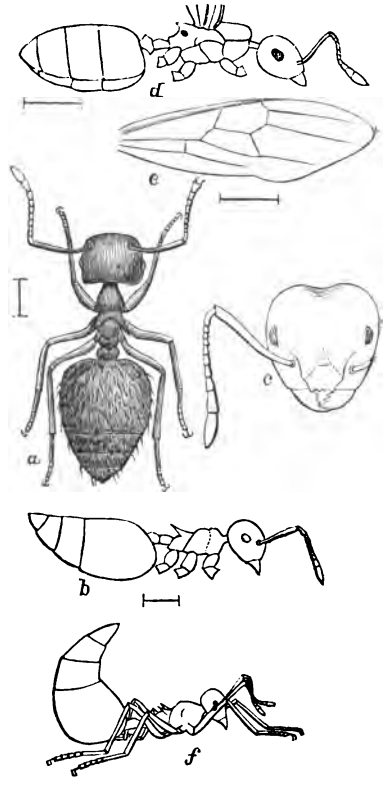

Fig. 182.

Cremastogaster lineolata: *a*, *b*, large worker; *c*, its head; *d*, female; *e*, its wing; *f*, small worker. (After McCook.)

Following the ants, we have the great series of wasps, of which there are several families, but which for our purpose need not be

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specially distinguished. As was the case with the ants, wasps differ very greatly in habits. Some of them are solitary, that is, a male and female form a pair, which build a nest and produce young, which are also male and female only. Others are social—that is to say, besides the male and female, there are also workers produced, as is the case with the bees. We have a very large series that are fossorial or digging wasps, living largely in the ground, in which they excavate burrows and form cells stored with food for their larvæ. Others make channels in wood, and sometimes in living plants. The legs are formed for digging, and are not fitted for collecting pollen. Most of them are provided with stings in the female, and this sting is really a modified ovipositor.

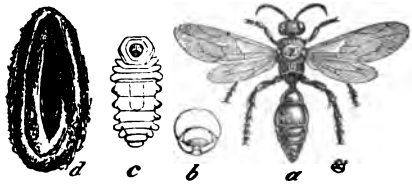

Fig 183.

White-grub parasite, *Tiphia inornata*: *a*, imago; *b*, head of larva; *c*, larva; *d*, cocoon. (After Riley.)

One series of these digging wasps, the *Mutillidæ*, is believed to be parasitic, or at least carnivorous, laying its eggs in the nests of bees, principally bumble-bees, and the larvæ feeding upon the larvæ of the bees. These *Mutillidæ* are frequently wingless, and resemble large ants, for which they are sometimes mistaken, but from which they differ by being furnished with an exceedingly vicious sting. They are often yellow or red in color, with black bands, and are seen running on sandy spots very much more rapidly than any true ant ever runs.

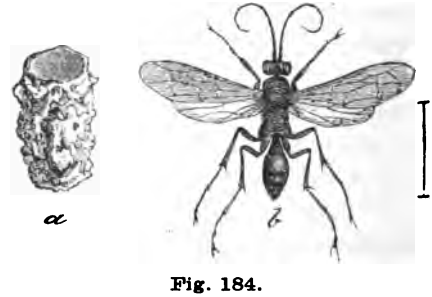

Fig. 184.

Agenia bombycina and its cell, which is to be filled with spiders. (After Riley.)

In the family *Scoliidæ* we have some that are said to be parasitic, and one species, *Tiphia inornata*, a black form, feeds upon the white grub or larva of the May-beetle.

The family *Pompilidæ* contains species that generally burrow in

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sandbanks, provisioning their cells mostly with spiders, which they first paralyze. Some species, the legs of which are not fitted for burrowing, construct mud cells, placed irregularly side by side, upon walls.

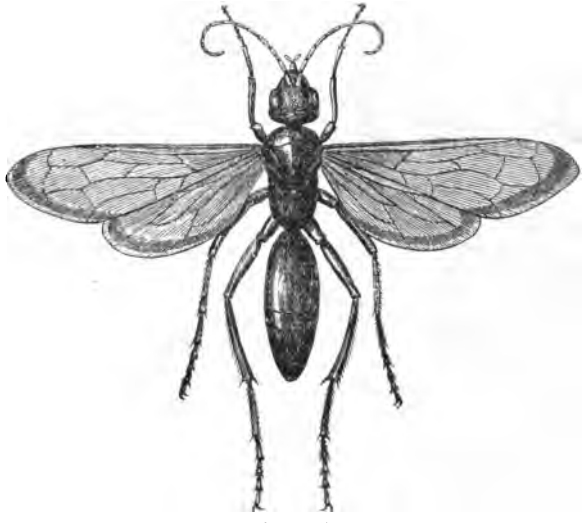

Fig. 185.

Pepsis formosus: tarantula-killer. (After Riley.)

Others, belonging to the genus *Pepsis*, which are among the largest of our *Hymenoptera*, prey upon the tarantula. The habits of these

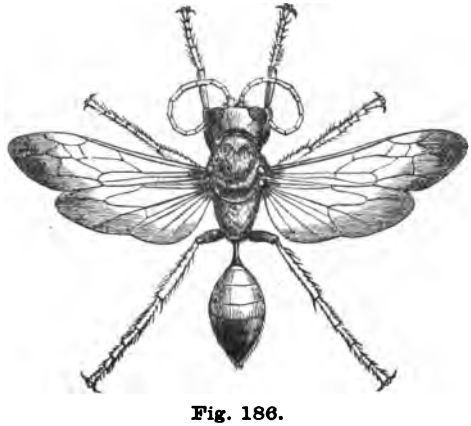

Fig. 186.

Sphex ichnumonea.

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insects are extremely interesting, and particularly this habit of storing their nests with living spiders upon which the larvæ of these insects feed. The spiders are not killed but are carefully stung in such a way that they lose the power of motion and retain just life enough to prevent them from decaying. The young larva when it hatches finds itself in the midst of a supply of spiders, any one of which could destroy it with ease were it in possession of its faculties, but as it is it bores into the body of first one and then the other, feeding upon them until, when the entire supply of food is exhausted, the wasp larva has obtained its full growth and is ready to change to a pupa. Some others, belonging more generally to the family *Sphegidæ*, provision their nests with caterpillars as well as spiders, and many of this family build mud nests not only on walls but under the eaves of houses, and sometimes on shrubs and trees, occasionally of quite regular and pretty form. If we open some of these mud nests at the proper season of the year we will find them stored just as closely as it is possible to pack them with spiders or caterpillars, and no cell contains more than one kind of food. It is either all caterpillars or all spiders, and it is quite remarkable how nearly of a size the stored insects are. The number of caterpillars collected and destroyed by these mud wasps is enormous, and the insects rank, therefore, as among the most decidedly beneficial. In the family *Bembecidæ* we have some of our largest

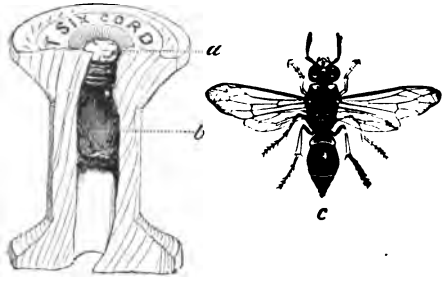

Fig. 187.

Odynerus flavipes and its mud nest, built in a spool; the nest stored with caterpillars. (After Riley.)

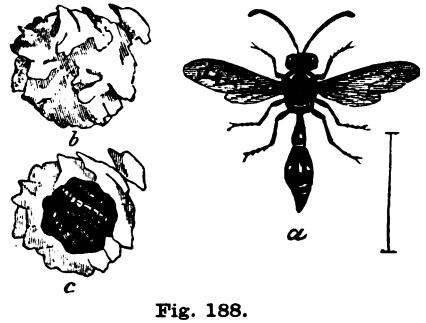

Fig. 188.

Fraternal potter-wasp, *Eumenes fraterna*: *a*, wasp; *b*, its cell; *c*, same broken open to show the caterpillars stored in it. (After Riley.)

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species, one of them which occurs in this State being nearly two inches in length, and this has the interesting habit of feeding upon cicadas or harvest-flies, stinging them and carting them to its burrow as food for its larvæ. The species is more common southwardly, but occurs some years in considerable abundance from the middle of the State southward. It is rarely found north of Newark. In the family *Philanthidæ* we have species which are partial to different species of weevils, destroying a great number of their larvæ as food for themselves and their young, and of course these are also decidedly beneficial.

Fig. 189.

Female Sphecius carrying a cicada to her burrow. (After "Insect Life.")

In the family *Vespidæ* we have the social wasps, commonly known as the "hornets" and "yellow-jackets." They are all paper-makers, not out of rags, but out of wood; alighting upon some wooden surface exposed to the weather, they gnaw off with their strong jaws the

Fig. 190.

Larva of Sphecius feeding on cicada in burrow. (After "Insect Life.")

minute filaments of wood which have become partly detached by the action of the elements and chew them up into a fine pulp, which they afterwards spread out into thin sheets of strong, gray, water-

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proof paper, that forms the material of their nests which are found generally suspended from the branches of trees, and sometimes in the corners of outbuildings. Some species, for instance the yellow-jackets, previously noticed, build their nests underground, much on

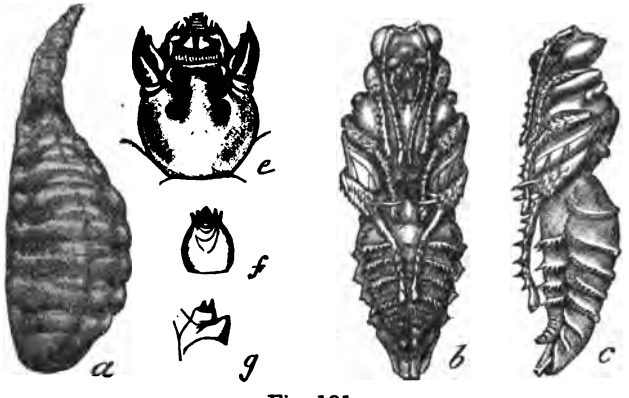

Fig. 191.

a, larva of Sphecius; *b*, *c*, pupa; *e*, *f*, *g*, details of larva. (After "Insect Life.")

the same principle as those built above ground. The species of *Polistes*, which have a more slender body, build combs or a series of paper cells in various sheltered places, principally on the roof timbers of barns and other outbuildings; but always without an envelope or covering as is used in the case of the species of *Vespa*. In these social wasps we find workers represented as well as males and females, and many of them prey upon other insects.

Fig. 192.

White-faced wasp, *Vespa maculata*. (After Riley.)

As a whole, we may say that the wasps are decidedly beneficial insects. There are none that can be considered as injurious, while it has been shown that a great many of them subsist entirely upon insects that are injurious to the farmer. To be sure their habit of feeding upon spiders is not one that is especially to be commended, for spiders are themselves useful, and also destroy a great number of injurious insects; but the balance is largely in favor of the benefits to be derived, and hence wasps should not be wantonly disturbed.

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Highest in the series of the *Hymenoptera* are the bees, solitary and social, and these are of very great interest from their habits and their social organization. All bees, in their larval as well as adult stages,

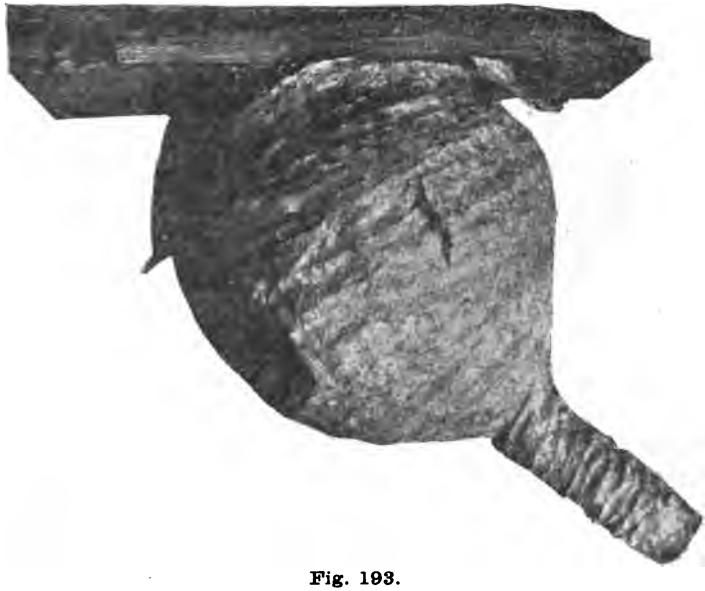

Fig. 193.

Nest of *Vespa maculata*, just started. (From a photograph)

are feeders upon honey and pollen, and they make their cells and nests in a great variety of ways. Some of them, like the digging wasps, make their cells underground. Others, like the carpenter-bees, bore immense holes in dead wood; others live in the hollow

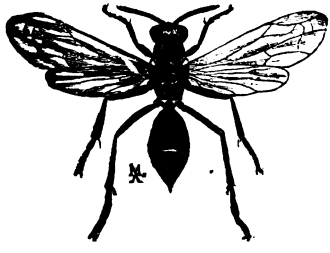

Fig. 194.

Polistes americana. (From U. S. Dept. Agri.)

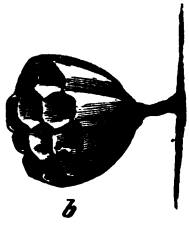

Fig. 195.

Nest of *Polistes*, just started. (After Riley.)

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stems of various plants, while others again excavate the pith in plants, like the elder, for instance. Some of them make their cells of fragments of leaves which they cut from the plant. It is quite usual to

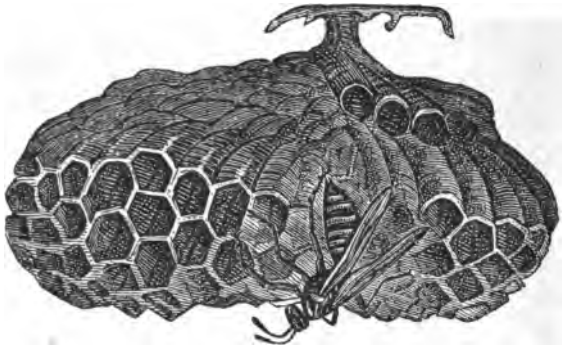

Fig. 196.

Nest of *Polistes gallicola*. (After Figuier.)

see on rose bushes leaves which have a semicircular piece cut out from the edge, and this is the work of these leaf-cutting bees. In so far as they thus disfigure certain plants, they may perhaps be considered somewhat injurious, but no real damage is ever done, and the bees generally make up what little trouble they cause in this way by their usefulness in fertilizing the flowers of very many species of plants. No agency among insects compares with bees in this important function, and an abundance of bees in an orchard generally means a good setting of fruit, while on the other hand an absence of bees, or a spell of weather which prevents their flight, will result in the absence of a set. Some clovers are almost entirely dependent upon bees for fertilization, and until bumble-bees were introduced into Australia no red clover seed could be obtained. Bees are therefore beneficial, not in the sense in which carnivorous, predaceous or parasitic insects are beneficial, but in

Fig. 197.

Hind tibia and tarsus of a honey-bee. (After Figuier.)

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really a much higher and more important sense, because they influence the set of the fruit in the first place, and wherever horticulture forms a leading industry apiculture should also be carried on. The most important habit which makes bees so useful in fertilizing plants is that of gathering pollen. Pollen is needed as food for the bee larvæ, and the bees fly from flower to flower, robbing each of this substance, but incidentally also pollenizing almost every flower visited. A habit of theirs to visit only flowers of one kind in each flight additionally favors this result. The pollen is gathered in little round balls or lumps, which are carried in the "pollen baskets," situated on the posterior legs, and none but true bees are furnished with these structures; even in them the males are without the baskets, since they do not work. The direct benefit to be derived from cultivating bees for honey does not enter into the scope of the present paper.

We have thus covered in a very general way, and of course far from completely, all the orders of insects, with the special view of pointing out those that are beneficial, and including a brief description of how they may be recognized. It is manifestly impossible to go into much detail in a report of this character, but it is at least important for the farmer to know that insects as a whole are not to be universally condemned, for there are many more which are active in his behalf than there are seeking the destruction of his crops; and I have tried to show that nature makes efforts to prevent too much injury to plant life from those species which feed upon it. I have tried to show, too, that it is man's interference with nature's methods which induces and favors the undue multiplication of those forms that feed upon cultivated crops, and I have tried to teach that as man has disturbed nature's balance by his own acts, he must either bear the penalty or he must himself take active measures for his own protection. We cannot rely upon nature to repair disturbances that we ourselves have caused. We must, by active measures, ourselves seek to remedy them, and while all series of parasites and predaceous forms are active in the farmer's behalf, yet they will never suffice for his protection without his individual effort. It is necessary, further, that crops be grown in such a way as to prevent the development of the injurious species, or they must be protected by means of poisons or otherwise.

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